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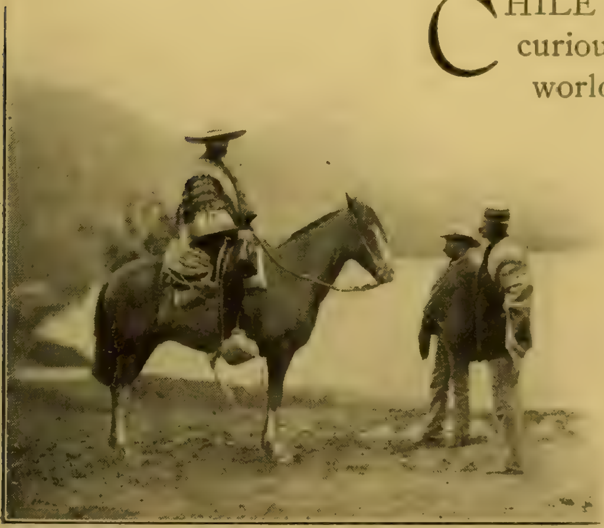
THE INDUSTRIAL FUTURE OF CHILE IN CONNECTION WITH THE PANAMA CANAL.

By G. Fred. Collins.

For many of the statistics in the following article I am indebted to my old friend J. Parker Read, Esq., the pioneer salesman and probably the largest introducer of American goods in Chile.—G. F. C.



A COUNTRY GENTLEMAN OF CHILE.

CHILE is probably one of the most curiously shaped countries in the world. Stretching as she does a distance of about 3,000 miles along the Pacific coast of South America, she will receive more benefits by the opening of the Panama Canal than any other country of South America; for with her numerous seaports and extensive coast line, and nearly 1,000 miles of navigable rivers and lakes, with a mean territorial width of only 100 miles, one can readily see how dependent her commerce must be upon the sea.

The northern extremity of the country is at latitude 17° 57′ south, and Chilean boundaries extend to the southern extremity of the Continent, mainly between the Andes and the Pacific ocean. The total area is 267,000 miles. She already has a navy of more than forty vessels and an auxiliary passenger fleet of twenty-six steamers.

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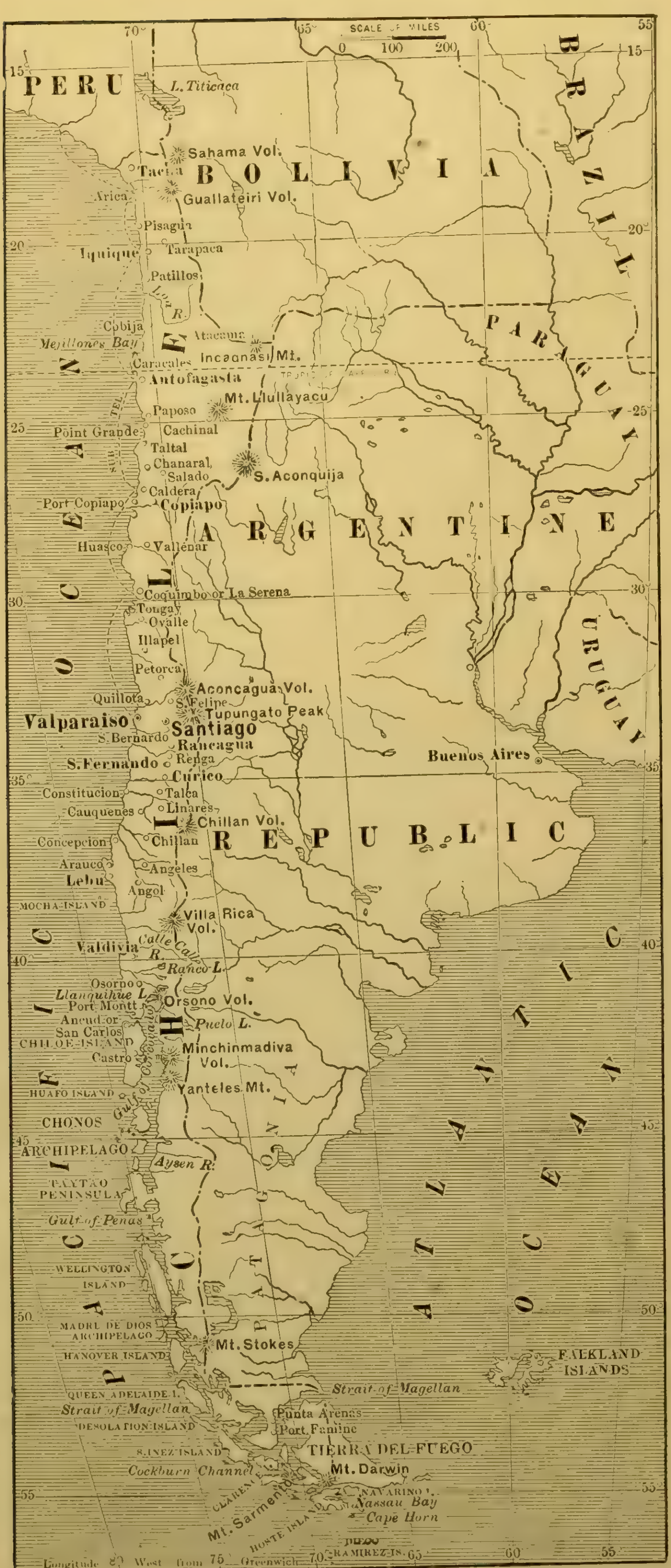


In the accompanying map, the Cordilleras are not shown, as they would confuse the reading. The international boundary, shown by a broken line, follows the crest of the Andes.

Chile is a very rich and powerful country, considerering her area and her population of between three and four million people. The opening of the Panama Canal will bring her more than 4,000 miles nearer to the markets of the United States and Europe. Her foreign commerce approximates about $300,000,000 annually, and requires about 8,000 vessels with shipping capacity of over 10,000,000 tons. Her exports exceed her imports by about $40,000,000, and the merchant marine of Chile numbers nearly 200 vessels

THE ISLAND OF JUAN FERNANDEZ. THE SOLITARY LIFE OF ALEXANDER SELKIRK ON THIS ISLAND SUPPLIED THE BASIS OF THE STORY OF ROBINSON CRUSOE.

Belonging to Chile, and 400 miles off the Chilean coast.

with a carrying capacity of 100,000 tons. Her passenger steamers, which travel the west coast from Valparaiso to Panama, are amongst the finest coastwise vessels in the world, and when the canal is completed we may expect to see the proud flag of Chile in northern harbors daily.

IQUIQUE, ONE OF THE PRINCIPAL NITRATE PORTS.

TALCAHUANO. FORMERLY A PORT OF CALL FOR WHALERS. PROMINENT IN THE MILITARY HISTORY OF CHILE. NOW THE SITE OF A NAVAL SCHOOL.

CORONEL. SHIPPING PORT FOR THE COAL FROM THE LOTA MINES.

The naval and military institutions of Chile are of the highest character, and the country has always maintained a formal army and navy. Today they have the discipline and armament of the most advanced nations. The military school is in Santiago, and the naval academy in Valparaiso. Cadets are instructed on the training ship General Baquedano, after which the midshipmen are sent to other parts of the world to complete their learning. There are also special schools in Valparaiso and Talcahuano, which latter in olden times was the port for whalers.

THE HARBOR OF LOTA, IN THE SOUTH OF CHILE, A COAL-SHIPPING PORT AND THE SITE OF COPPER SMELTERS.

The State railways in present operation extend more than 1,500 miles and are valued at over $100,000,000. These, together with the private railways, give the republic more than 3,000 miles of railroad. The State railways transport annually more than 7,000,000 passengers and over 3,000,000 tons of freight. In Santiago, which is the capital of the country, there are more than 60 miles of electric tramway. The Chilean post offices handle 50,000,000 pieces annually, and the postal money-order department more than $10,000,000. There are 15,000 miles of telegraph and telephones connecting all the principal towns in the republic.

The famous coal mines of Lota and Coronel have an annual yield of 1,000,000 tons and employ some 9,000 laborers. This not only supplies all Chile's needs, but also coals nearly all the European steamers entering her harbors. The coal is what is termed "soft,"

THE UPPER PICTURE SHOWS TOCOPILLA, ONE OF THE IMPORTANT NITRATE PORTS OF NORTHERN CHILE, AND THE LOWER COQUIMBO, NOTED FOR ITS COPPER MINES.

but it is of good quality. The country imports some hard coal. The most important mineral industry is of course the nitrate of soda. Chile at present has over one hundred nitrate works. The crude material (called *caliche*), is found under a conglomerate, in beds varying from a few inches to 12 feet in thickness. The process of extraction is one of leaching and refining by crystallization. About 1,400,000 metric tons of 2,204 pounds each are annually produced, estimated to be worth $54,000,000 in Europe. About four-fifths of all the nitrate exported goes to England and the Continent, Great Britain alone taking one-third and Germany a little less. A large amount of British capital is invested in the nitrate fields, sixteen of the larger companies alone representing a capitalization of more than £8,000,000. The Chilean government exact a duty of $11.52 a ton on all nitrate exported. I learn that an enormous deposit of nitrate has just been discovered in the Sahara desert. This is advance information and very important.

AVENIDA ERRÁZURIZ—THE QUAYS AT VALPARAISO.

In metal mining, copper comes first both as to present output and further opportunity. The country needs modern metallurgical

VALPARAISO. THE LEADING SEAPORT OF CHILE.

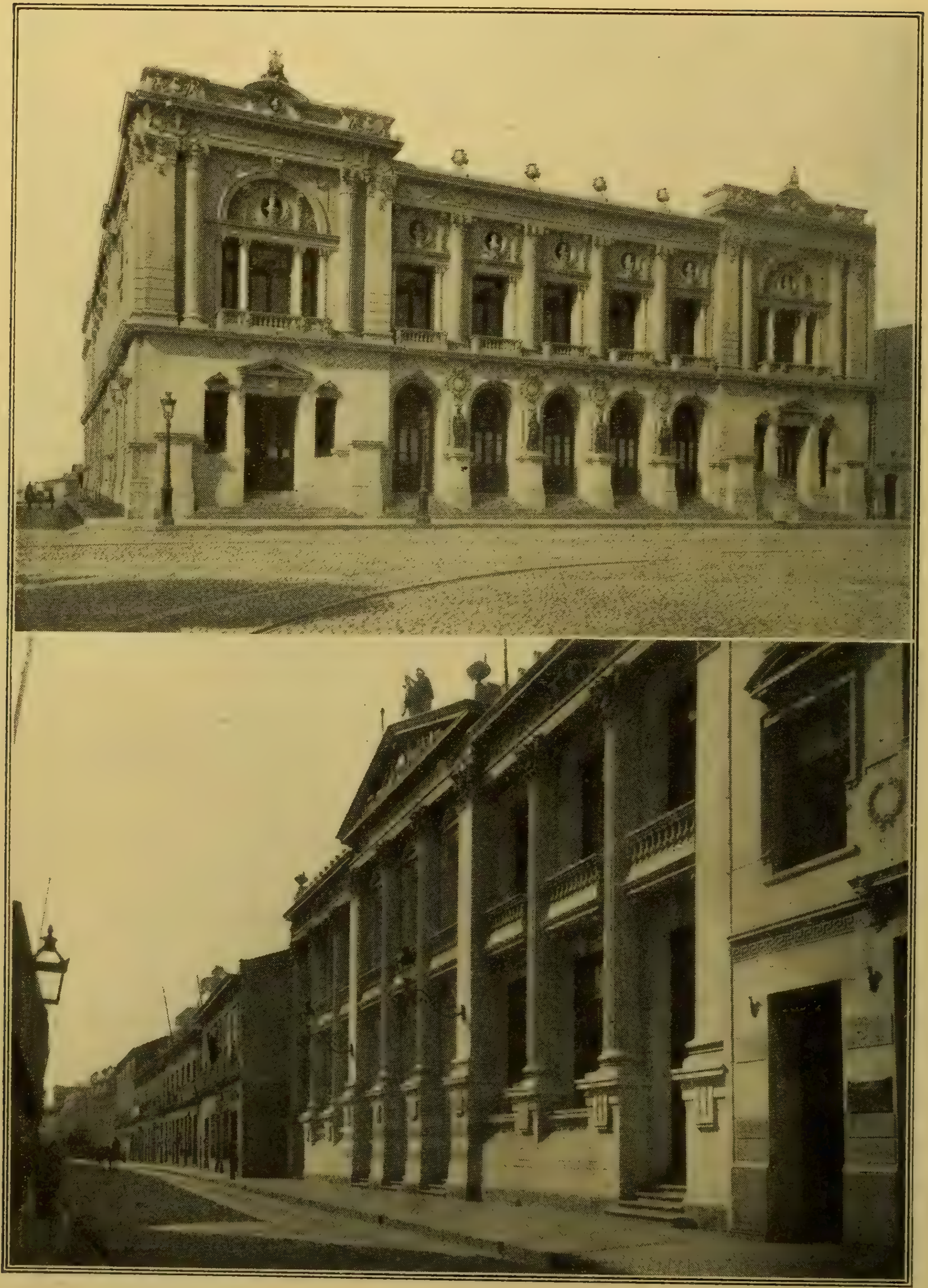
processes and knowledge of successful methods for handling low-grade ores. The present production is about 30,000 tons of copper annually. Manganese is also an important industry. Silver, once very highly profitable, has declined; 74,000 kilogrammes of silver were exported in 1900. Promising gold deposits exist, especially in southern Chile. $30,000,000 in gold, gold ores, and matte, have been exported in the past ten years.

A very important product of Chile is wine, and more than $50,000,000 have been invested in this industry. It will no doubt be surprising to learn that Chile stands second to France in clarets, and that her wines are equal to the best in the world. The climate is especially favorable for wine-growing, and in most of the valleys vineyards are found. Another agricultural industry which promises a brilliant future is the cultivation of beets; the opportunities are apparent when we consider that the country buys about $10,000,000 worth of sugar annually. The government has recently passed a special law in connection with this industry providing a bounty of 2 cents a kilogramme on refined sugar produced in the country. Chile raises the

VALPARAISO. COMPLETING THE PANORAMA SHOWN ON THE OPPOSITE PAGE.

finest line of livestock that can be found anywhere, and throughout the farms of Chile you will find the greatest interest in blooded stock. An excellent quality of wool is exported; everywhere in the southern republic the spirit of progress is evident and the saying seems justified which often classes the Chileans as the "Yankees of South America." In fact, after years of travel through the various countries of South America, there is no place I have visited where the spirit of progress is so much shown as in Chile. This progress is remarkable when we take into consideration that the country gained its independence from Spain less than ninety years ago.

Santiago is the metropolis of Chile, and has often been termed the "Paris of the Western Hemisphere." To it the wealthy persons of the provinces go to settle down after they have made their money. It is certainly a beautiful city, with its grand Plaza de Armas, and its long Alameda running the length of the city. In the centre of the city, rising to a height of over 300 feet, is the famous hill of Santa Lucia with its church, restaurants, and beautiful gardens. I went there to have breakfast nearly every Sunday morning during the time I was in Chile.



VICTORIA THEATRE, VALPARAISO, AND BANK OF VALPARAISO.

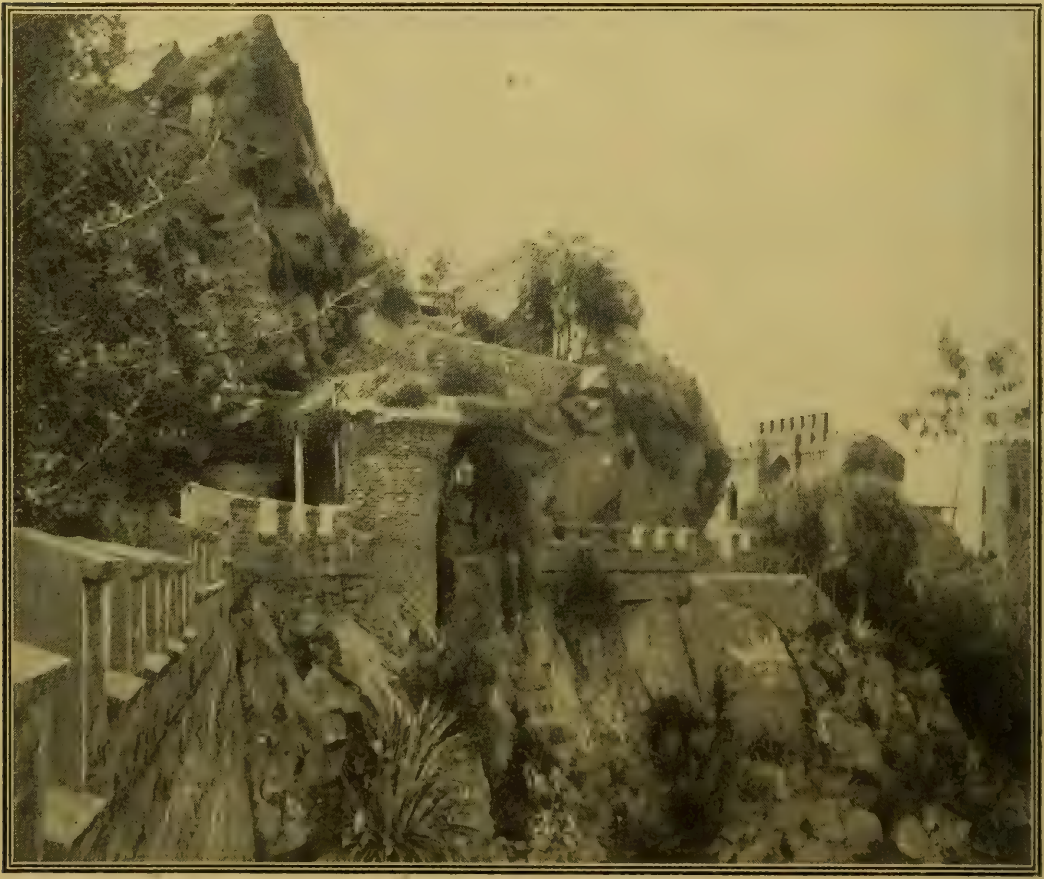
and admired the wonderful snow-capped Andes, covered with their eternal snow, making a beautiful picture to sit and dream over while you are enjoying your coffee and cigar.

Valparaiso, the leading seaport, is next to San Francisco on the west coast in magnitude and commerce. It overlooks the blue bay of the Pacific. The streets are lined with fine shops, offices, banks, and warehouses. The loading and unloading of vessels is done by hydraulic power machinery. They have also a long mole in front of the custom houses.

PLAZA DE ARMAS, SANTIAGO.

A Chilean girl cannot be said to possess such liberty of action as an English or an American girl; women certainly occupy an inferior position, due mainly to national custom from which they have not as yet been able to emancipate themselves. The young woman is hampered by an etiquette which deprives her of the opportunity of becoming acquainted with young men, of studying their characters, or of forming friendships with them, except under the eyes of a chaperone. To be courted by one except in this manner would be considered an impropriety, but these customs are beginning to be relaxed somewhat, and woman's right to labor is being encouraged and respected, and in a great many of the shops you will find young women in attendance as in New York. In fact, nowhere else in the world probably is she to be found as a conductor of a street car.

PLAZA PRAT, NEAR THE SHIPPING WHARVES, VALPARAISO.



SANTA LUCIA, SANTIAGO.

A CHILEAN COUNTRY HOUSE, AND A VIEW OF CHILLAN ON A MARKET DAY.

Illustrating the agricultural resources of the country, which furnish the basis for internal transportation systems.

The Chilean woman is a very devoted church goer, and probably keeps the church from utter extinction, for the men seldom go. With her figure closely enveloped in her manta, which she wears hood-fashion, she goes tripping to church in the early morning, carrying in her hand her prayer book, followed by her servant who carries a yard of carpet or fancy mat, upon which the señorita kneels on the stone floor of the pewless cathedral. No matter what her station in life is, the Chilean girl puts off her bonnet, dons the manta, and kneels in the centre of the church with her worshipping sisters, however poor or despised they may be; thereby putting herself on a level with them and doing away with all the rivalries of dress during church hours. The Chilean girl is certainly very attractive, with her olive complexion, sparkling black eyes, and rosy cheeks. The climate, being more invigorating than in Peru, naturally gives her a better color.

A CHILEAN SENORITA ON THE WAY TO MASS.

The "haciendados" of the country are particularly courteous towards all foreigners, taking them into their houses, and giving them the best of care and attention. A very amusing story is told of one of the representatives of the United States government who was visiting a Chilean gentleman, and being offered a fine pair of horses, accepted them. They were sent the next morning to his house. It is the custom in this country if you admire a thing, for your host at once to offer it to you; but of course it is considered equally a matter of etiquette for you to decline. Indeed, it is very impolite to accept these offers, as the people simply are endeavoring to show you their good will.

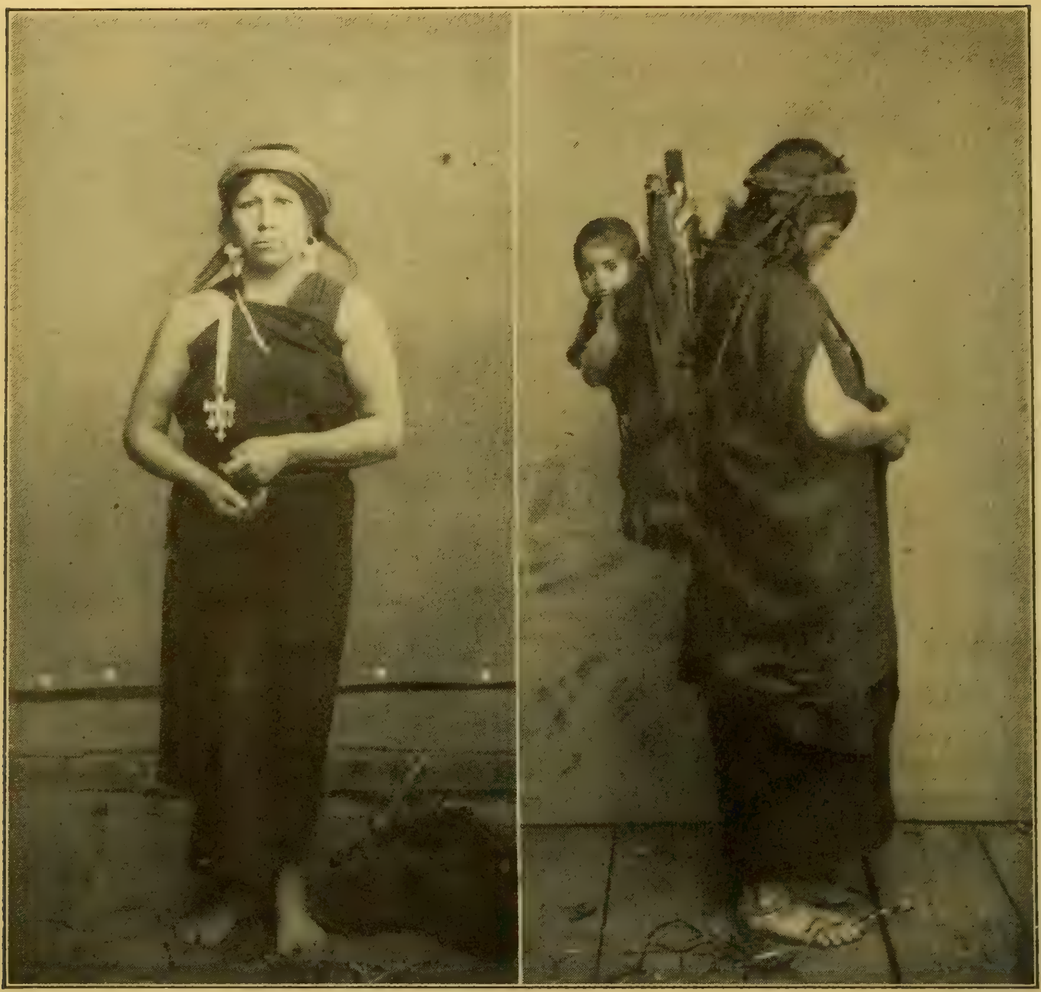
The original inhabitants of the country are known in history by the name of "Araucanos" and were savage tribes, which never submitted to the Spanish rule. Some of the descendants of this people are still existent and live on the land which has been set aside to them by the government, in the part of the territory they fought over for nearly 300 years. The spirit of these people remains in the popular masses and distinguishes the Chileans for their pride, their valor, energy, and aptitude for learning.

A VALPARAISO CONDUCTRESS.

The Araucanian Indians are rather an intelligent looking lot of men about medium height. They have straight hair and the peculiar eyes common to the Indian races. They are of light copper color and dress in the poncho, generally fastening around the waist a blanket which hangs like a short skirt, with a red handkerchief tied around their heads. The women wear the poncho folded like a shawl and coil their hair in tresses around their heads, ornamenting the braid with a string of beads. They wear large silver earrings, often several pairs at the same time, and necklaces of beads or of leather studded with silver ornaments. They generally go barefoot and pin their ponchos with silver ornaments. The women do the weaving and make the clothes for both themselves and the men.

A CHICKEN SELLER IN VALPARAISO.

Bread, fruit, etc., are similarly brought to the door in huge panniers.



TYPES OF ARAUCANIAN INDIANS.

Their huts are usually orderly and clean—a thing which cannot be said of the Peons. They generally have several wives and these with their children dwell together in apparent peace. Their mode of taking wives is similar to a custom which prevails in many barbarous countries. The young man goes to the home of the prospective bride, having settled with her father for her, and forcibly carries her off—at least, he and his friends appear to use force; they are in reality allowed to take the girl away with only a slight show of resistance. The pair then retire to the woods, and after dwelling there together for a few days, they go to the husband's domicile, where they live afterwards as husband and wife. The women have the same custom which prevailed among the ancient Incas—that of going alone to the forest streams at the time of childbirth; when the child is born it is washed in the river, wrapped in a blanket, and bound to a board, where it remains until it is time for it to learn to walk.

THE CORDILLERAS ON THE LINE OF THE TRANSANDINE RAILWAY.

The stream in the upper view is the Rio Colorado. The lower picture is the valley of Los Horcones.

SALTO DEL SOLDADO.

Of engineering enterprises other than mining or the development of water powers, the most important and most immediate in interest is the Transandine railway, which after half a century of stagnation or very slow progress seems at last on the point of energetic prosecution to completion. The Chilean government has called for tenders (which are to be opened at Santiago in May, 1904) for the building of the one remaining link necessary to connect the Chilean lines with the Argentine railways, which now are reported complete to the boundary. The section to be let by Chile is about 25 miles in length, but a considerable part of distance must be in tunnel. It extends from Salto del Soldado (4,100 feet above sea) to the "cumbre," or summit, (12,800 feet). The Transandine railway proper is the entire stretch between Mendoza and Los Andes, but the line is built

BRIDGES ON THE COMPLETED PORTION OF THE TRANSANDINE RAILWAY. THE UPPER ONE IS OVER THE RIO MENDOZA.

from Los Andes eastward to Salto del Saldado and from Mendoza westward to the "cumbre," the route being that known as the Uspallata Pass. When this last link is closed, the journey from Buenos Ayres to Valparaiso will be made in 48 hours, though differences in gauge of various portions of the line will necessitate two or more

NATURAL BRIDGE IN THE CORDILLERAS.

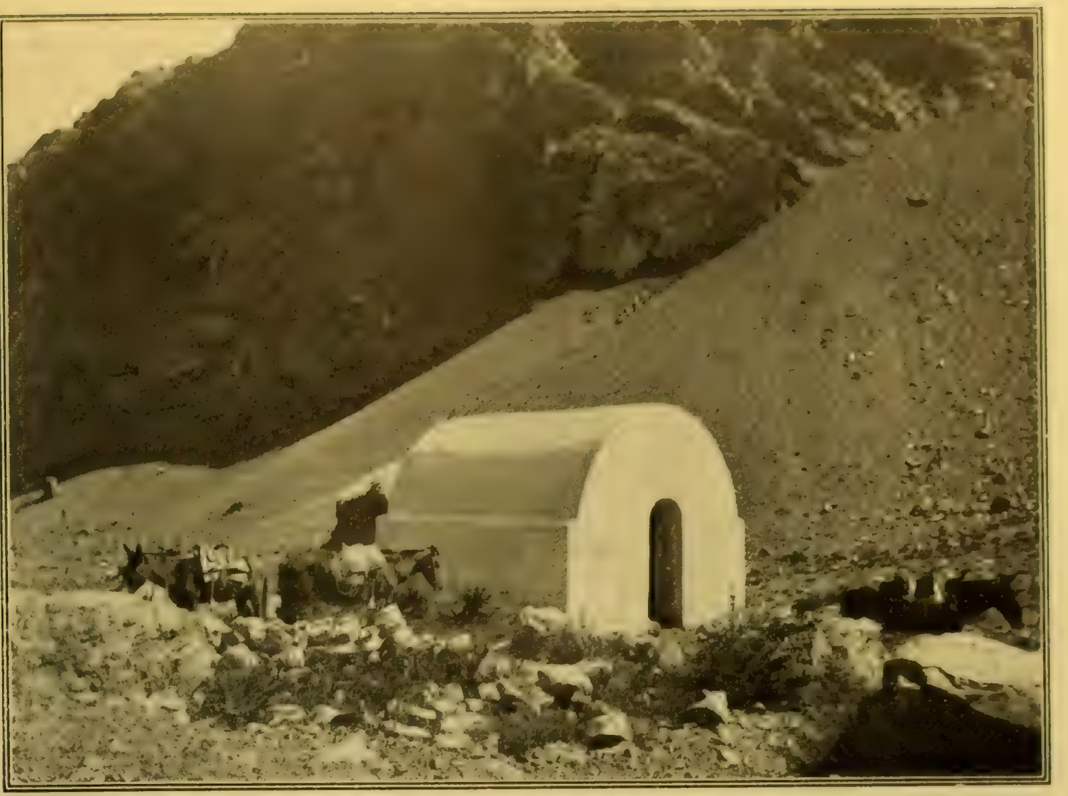
Called "Puente del Inca." It is near some celebrated warm baths, and the formation is largely due to deposits from highly charged mineral waters.

transfers en route. The line is expected to be a paying one, passenger traffic being an important item and the cattle business very profitable, the movement being westward into Chile from the Argentine pastures. I crossed the Cordilleras some years ago from Los Andes, following the line where the railway will run and where the portion reaching Salto del Soldado was then under construction. The dividing line between Chile and the Argentine Republic is marked by a line of iron posts planted on the crests and extending almost to Cape Horn.

The Transandine line is to be of one-metre gauge, and in preceding studies the Abt system has been proposed for several sections aggregating nearly 18 miles. "Works of defense" against the snows and gales of the winter are essential.

The climate of Chile is one of the finest in the world; the temperature varies hardly 25 degrees from the middle of summer to the middle of winter. In coming around the Horn, one passes from cold and stormy weather into this beautiful climate almost as soon as the shores of Chile are sighted. The last trip I made we were five weeks off the Horn, but forty-eight hours after getting around it we found delightful weather, with a good steady trade wind blowing us up the coast. The southeast trades seem to bring up from the Pacific better weather than exists on the Atlantic side of Cape Horn.

When the Panama Canal is finished all the immense amount of material which is now brought around the Horn to and from Chile



A REFUGE STATION IN THE PASSES OF THE ANDES.

The great thickness of the walls is designed to protect the traveller from the severe cold due to the altitude. The only opening is toward the north—the warm quarter.

A PARTY OF ENGINEERS, RECONNOISSANCE SURVEY OF THE TRANSANDINE RAILWAY

THE FALLS OF LAJA—THE UNDEVELOPED NIAGARA OF CHILE.

will of course be carried through it. The passage through the Straits of Magellan has always been an extremely dangerous one, and a great many fine ships have been wrecked in that fog- and wind-infested region—one of the most desolate of the seas.

CAPE PILLAR, AT THE ENTRANCE TO THE STRAITS OF MAGELLAN.

THE APPRENTICESHIP SYSTEM OF THE ALLIS-CHALMERS COMPANY.

By Philetus W. Gates.

The best technical literature is that which is written about the most important problems by the men who have been most successful in solving them, and who have the faculty of describing their methods clearly. Mr. Gates' article has all three qualities.—THE EDITORS.

THE means adopted by any manufacturing concern for the training of shop-hands or other employees are necessarily an outgrowth of its needs and its environment. That these, correctly interpreted, may lead to widely different policies, is well shown by the diversity between the systems described in this Magazine in December and January last. And yet the system in vogue at the Westinghouse Company is certainly very comprehensive and very good, and the same is equally true in relation to the methods adopted by the Brown & Sharpe Company. As a matter of fact, apprenticeship systems in different works must vary with the conditions there extant and while they may seem diametrically opposed, they may in each instance be the best for that particular concern.

There is no uniform system of apprenticeship in the different plants of Allis-Chalmers Company, although two forms of apprenticeship agreements are being used; one of these is the ordinary apprenticeship agreement and provides only for four-year apprentices, putting all apprentices on a dead level, without regard to technical education or other conditions. The other apprenticeship agreement, which is in full operation at one of the plants, contemplates three classes of apprentices, the first class being four-year apprentices, the second class three-year apprentices, and the third class two-year apprentices. Apprentices of the first class are required to have passed at least the sixth grade in the grammar school, or to have had equivalent education. The second-class apprentices are required to have been graduated from the high school and to have taken a course in manual training. The third-class apprentices are required to have been graduated from some of the universities or some of the manual-training schools, like the Armour Institute, Purdue, Worcester Polytechnic, etc., and to have had the manual training which goes with these schools.

Speaking in general terms, from the first class it is the expectation we will gain our regular machinists, sub-foremen, foremen, and inspectors; from the second class, erecting engineers, general foremen, assistant superintendents and superintendents; and from the third class, salesmen, engineers and technical experts. No set routine has ever been laid out for the different classes, for the reason that the plant in which this form of apprenticeship has been in force is a small concern employing only six or seven hundred men, and the general foremen have been able to give the apprentices personal attention and to direct their progress according to the ability shown.

This form of apprenticeship has been introduced in one of the larger plants for the second and third classes of apprentices, and probably in the near future some general system of service and advancement will be prepared; and if the system is extended to all of the plants, it is more than probable the apprentices will be under the direct supervision of some person selected for this work, as has been done in the case of the Westinghouse and Brown & Sharpe Companies.

It goes without saying, of course, that the apprentice of the first or second class, may, through merit, arise to any position in the company; and as a matter of fact in the plant first mentioned great care has been taken to give the first class apprentices every opportunity.

In the plant first mentioned, the first-class apprentices are obliged to present an original drawing each month, the apprentice himself selecting the subject. There are offered four prizes each month, the first being $2.00, second $1.50, third $1.00, and fourth, fifty cents, and these prizes are awarded on the basis of progress, not for the best drawing or best subject. When an apprentice has secured a certain number of prizes of any one class, or a combination of classes, he is then exempt from making further drawings, because it is supposed that he is proficient enough for all practical purposes for his class.

In addition to furnishing the drawings, this class of apprentices is obliged to attend some night school, or to take a course in the Scranton School of Correspondence, or some other similar school. The second- and third-class apprentices are supposed to be proficient enough in drawing not to require the same course as the first-class apprentices, but if it is ascertained that they are not able to read drawings or to make drawings properly, they are also obliged to have instruction in this line.

The selection of apprentices is made by the superintendent of the works, or the general foreman, and is not based on the comparative scholarship record, as we have an idea that it is not always the student who has the best scholarship record that makes the most proficient workman or the best business man. My experience, both at school and as a business man, has been that there are within every young man latent forces which are only brought out when proper opportunity is afforded and that this opportunity must be of a practical nature. The opportunity for a young man to shine in scholarship is, of course, restricted in the largest degree to the superficial knowledge attained from the books and specialties which he is studying, and while a young man may make a very good showing in this direction, when it comes to using that judgment which is necessary to practical conditions, he is not able to do so, whereas another young man, whose showing may approach dullness, may be able to grasp the situation at once and produce results thoroughly satisfactory. In other words, the old saying "You are not able to judge how far a frog may jump by his looks," is applicable in this case, and the only safe and just way, in my estimation, is, after ascertaining that the character of the young man is good, to assume that the fact of his having gone through the course of studying necessary for the grade of apprenticeship which he is to enter is warrant of his ambition, and then give him a chance, weeding him out later on if he should be found wanting.

Probably as this system is extended in the works, it may be found of value to keep tabulated records, as is done at the Westinghouse.

No deposit is required by any apprentice, but on the contrary it is the policy to pay the apprentices such wages as will make them independent of outside support, on the theory that anyone may apply, regardless of financial condition.

The wages for the first class of apprentices are:
For first period of 2,750 hours— 9 cents per hour
For second period of 2,750 hours—12 " " "
For third period of 2,750 hours—15 " " "
For fourth period of 2,750 hours—18 " " "
The wages for the second class of apprentices are:
For first period of 2,750 hours—12 " " "
For second period of 2,750 hours—16 " " "
For third period of 2,750 hours—20 " " "
The wages for the third class of apprentices are:
For first period of 1,375 hours—15 " " "
For second period of 1,375 hours—18 " " "
For third period of 2,750 hours—22 " " "

An apprentice may terminate the agreement any time within the first six hundred hours, and the company can, under the terms of the agreement, terminate the agreement for incompetency, or any other good and sufficient reason. A vacation of one week is given in each year of service to each apprentice, for good service, and $100.00, $75.00 and $50.00, with a diploma, to the respective classes at the completion of service term, for the same reason.

In each of these classes it is expected that the entire time will be used in the machine shop, in the handling of tools, erecting, etc., unless for special reasons it is thought best to have some parts of the term used in the draughting room. This discretion is exercised more largely in the first class of apprentices. It is our object to have each class become thoroughly familiar with the practical work in the machine shop, believing that there is ample opportunity for pursuing the theory after they have served their time.

I thoroughly believe that it is the duty of every manufacturer to do his utmost to educate competent workmen through the apprenticeship system, but on account of the peculiar conditions obtaining in manufacturing in these days, the range of work in the shop is not always great enough to educate the apprentices properly. I therefore hold with Prof. Sweet, that there should be "Shop Schools" established by the various trades—for instance, that the National Founders' Association should establish one or more schools in different parts of the country, under the direction of a properly constituted committee, this school to be supplied with work, from the different members, in such proportions as are suggested by the committee, the members sending the work to pay therefor at such rates as will assure a profit for the school, or, not being able to do this, to make a money contribution.

Undoubtedly as organized labor is now conducted, there would be much opposition to these schools, but this is a matter which should not deter the manufacturers. It seems to me there are only two questions to be decided in this matter, viz:—"Is it right?" and "Is it good business?" If so, then the manufacturers should forward the work and advocate the idea, as they have had in the past to introduce many advanced ideas and improved institutions, against the opinions of organized labor. They should press the policy with all the vigor at their command, with the certainty that in the long run the plan will succeed and the benefits inure to the fraternity.

Such schools as these would be of great advantage to each trade in many ways known to every manufacturer, outside of simply turning out competent workmen, and it is my belief that the establishment of such schools cannot take place too soon.

WAGE-PAYING METHODS FROM THE VIEWPOINT OF THE WORKMAN.

By Henry Hess.

Mr. Hess's method of analysis is thoroughly scientific, in that it goes to the foundations of the subject and takes account of all the elements entering the problem; and at the same time it is thoroughly practical, in that it is addressed to working conditions and presented in graphic form, making the results instantly and clearly apparent. The paper is the first of three, taking up the advantages of the advanced wage systems from the viewpoint of the workman, the employer, and the invested capital.—THE EDITORS.

IN the entire relation of capital and labor there is probably no detail that is more vital than that of the payment to labor of its share in the return for industrial production. On both sides there is at present a quickening of interest, evident in the consideration given all proposals for reconciling differences arising out of the very humanly selfish desire to get as much and to give as little in return as possible. That this is a prevalent attitude must be clear to all observers of the attempt on the part of some unions and labor leaders to limit and fix the amount of work to be given in return for an also limited and fixed wage, and, on the other hand, of some employers to limit the amount that their men may receive in wages, quite apart from the return in work given.

It would be a libel on the general intelligence and would argue a pessimism not at all warranted by the very real advances made toward equitable dealing, to assume that such an attitude represents fairly that of the generality in the opposing camps; though unquestionably the latent mutual readiness to accord one another fair treatment and credit for good intentions is much obscured by the noisy mouthing of self-constituted leaders, self-imposed upon the tolerant and easy-going majority of both sides. If one were to believe these leaders, the sole aim of the employer on the one hand is to allow the workman to earn the barest pittance in wages in return for as large an amount of work as he can be cajoled or compelled to give; the aim of the workman is represented by the others to be as large a wage as can, by individual and collective bargaining and occasional intimidation, be secured for the least possible labor return. That, too, is the way the situation presents itself to those who can see in employer and employee only necessarily opponent forces. Many of these long for a return of the old patriarchal relation, forgetting that that had proportionately a far greater number of serious evils in its train than modern conditions at their worst have produced. It is more than probable that its lamentors would be among the first to find the "good old time" not exactly all their fancy painted, should it by any miracle be resurrected; of such return there is however small probability, as even those who regret the departure are agreed that adaptability to modern industrial conditions was not among the virtues of the "good old time."

The entirely legitimate desire to get as large a return as possible for the outlay of capital or work does not involve a necessary antagonism, provided the workman is ready to use his strength and intelligence genuinely, and the employer to consider the wage cost of his product rather than the workman's wage total. Living fairly up to this principle of fundamental equity does away with all serious causes of mutual discontent, as has been proven times without number. The only argument advanced against the principle is based on its leaving each workman unrestricted to increase his output up to the limit of his individual capacity, and the fear of sincere—and because of their very sincerity, dangerously obstructive—leaders that there may not be work enough to go around. Many a workman, and he of the best, has in my own experience, advanced as a reason for not taking advantage of guaranteed piece prices to increase his earnings by amounts readily realizable, that that would mean taking work and opportunity from his fellows. With many there is no reason to doubt the sincerity of this altruistic attitude, even while with others, and those the more evident in the public eye, it is an obviously assumed pose. Time may be safely relied on to bring about an harmonious adjustment, just as the unalterable logic of events has proven the fallacy of the similar belief in the harmfulness of replacing hand work by machinery.

There have been proposed many plans for stimulating the workman's interest in an increase of his production and of assuring him of the genuine identity of his and his employer's welfare. Until lately these nearly all took the form of some profit-sharing plan or other, with no great measure of general success to their credit. Such lack of success was in great part due to the length of time involved before profit distribution could be made, the smallness of the amounts falling to each individual as compared with exaggerated expectations, and the difficulties of dealing equitably with the voluntarily and involuntarily migratory element among the workers. Latterly more attention has been devoted to plans purposing the direct and immediate participation of the workman in the benefits arising from increased activity on his part, the benefit to manifest itself anew with each recurring payday in the pleasant chink of coin.

The merit of being the pioneer with a well worked out and competently introduced plant is due Mr. Halsey for his "Premium Plan"; from that have sprung many modifications, chiefly in Great Britain, where, especially of late, there has been manifested a much wider interest in the entire question than in the United States, probably owing to the greater intensity of the differences between employer and employed.

Another plan that has attracted much attention here is also of American origin; it has been worked out by Mr. Gantt under the stimulus of Mr. Taylor's highly original methods of works management. The method of paying for work by the piece is essentially of the same type as these more modern plans, and is as old probably as the substitution of voluntary labor for that of the serf and the slave.

Assuming that the workman has arrived at a general willingness to increase his earnings by an increase in his production, that plan of payment will seem to him best that promises the greatest recompense for the extra exertion of mind or muscle involved. An estimate of the relative value of the various plans from this point of view may be arrived at by contrasting the possible earnings per hour for savings of time ranging from none at all to the entire amount allowed. As it is not impossible that the time set for the completion of a "job" may be so short as to be unattainable by some individual workman, the effect of taking more time—that is, of losing time—is also to be considered. The possible earnings per hour may be calculated and tabulated for comparison; but columns of figures are at best difficult of digestion; instead, the facts are here presented in a graphical form on Diagrams 1 and 2, showing at a glance the entire relation of the various plans throughout the range of time saving or time lost. An hour is taken as the base time set; if less time is used that means "time saved"; if more time is occupied that represents "time lost"; the actual "hours used" are taken as the horizontal scale at the base of the diagrams; the vertical scale measures the "earnings per hour." Twenty-five cents per hour is taken as a convenient and readily convertible basis of "earnings per hour" under the ordinary day-pay plan; for other rates the results are naturally directly proportional.

Under the day-pay plan the earnings per hour are constant at 25

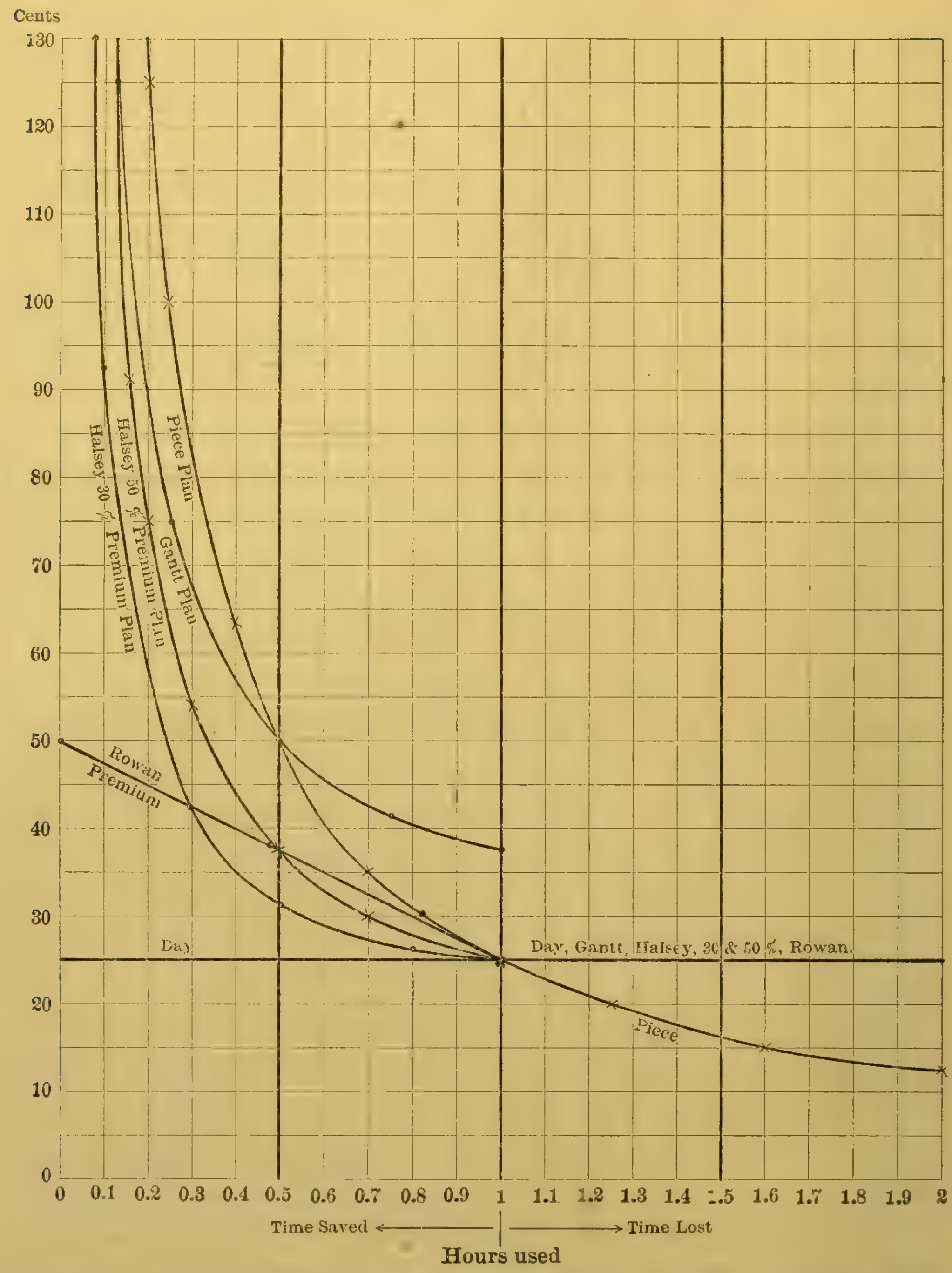


DIAGRAM I. WORKMAN'S EARNINGS PER HOUR, UNDER VARIOUS METHODS OF PAYMENT, WITH A BASE RATE OF 25 CENTS PER HOUR.

cents whether the workman save or lose time. Its characteristic is therefore the horizontal line in the Diagram 1 at a height of 25 cents per hour.

The next plan of general familiarity is that of piece work. Under that a saving of one-half the time would result in a doubling of the hourly earnings from 25 to 50 cents, while a further increase of production to the extent of using only one quarter of an hour would quadruple the wage takings per hour to 100 cents. The obverse side of the picture is the decrease in hourly earnings when more time is used than was set; a doubling of the time halves the earnings per hour. The possibilities of this plan are shown on Diagram 1 by the curved line marked "Piece Plan."

The "Halsey premium plan" contemplates the division between the workman and the employer of the savings due to an increased activity; the employer fixes a time—say one hour—for the work, and promises the workman a certain portion of the wage value of all time he may save, guaranteeing that the time rate shall not be changed unless the conditions on which it were based are materially altered; an alteration in the sense contemplated would be the introduction of new machinery of increased capacity. The employer further agrees to pay day-pay rates should the workman not find himself able to save time or should he actually take up more than that set as a base. The premium is that portion of the wage value of the time saved that is accorded the workman. Were the entire value of the time saved given as a premium then the plan would be identical with the piece-work system so long as time is saved, but not if time be lost, as under it the hourly earnings are then constant instead of decreasing. Halsey recommends 30 to 50 per cent. as a premium, the rate to be higher the greater the exertion required to save time. In Scotland a well-known firm of pump builders were the first to adopt the plan on the 50-per cent. basis, which accounts for its being there generally known as the "Weir" plan. The value to the workman of both the 30 and 50 per cent. plans are clearly indicated by the corresponding curves on Diagram 1.

A member of the Rowan firm, engine builders of Glasgow, Scotland, has devised a modification of the Halsey plan that makes the ratio of the premium paid and of the hourly pay rate the same as the ratio of the time saved to the base time. If no time is saved or more than the fixed time is used, the hourly pay is constant as under the Halsey plan. The slanting straight line marked "Rowan Premium" on Diagram 1 shows that when no time is saved the results under all plans are identical; if only a half hour is used instead of the hour set, the Rowan plan gives the same earnings per hour as the Halsey 50-per-cent. premium; if only 0.3 hour is occupied, the earnings agree with those under the Halsey 30-per cent. plan. The returns are throughout less than under the piece plan, but for the first, and therefore most easily made, time savings are greater than with the other plans.

Mr. Gantt fixes a certain time as that in which a piece should be done; if that time is reached the workman receives a bonus in addition to his day rate for the time occupied; if he does not reach that time, he is paid at his day rate. The time for the receipt of a bonus is so fixed that a competent workman should earn from 30 to 70 per cent. more than by day pay. The time to be allowed is determined by a careful study of the various elements entering into the doing of the work; the workman is then aided by being given minute instructions to which he is expected to conform. Assuming the average increase aimed at as 50 per cent., a workman having a day-pay rate of 25 cents per hour would receive 12½ cents bonus if he finish his work in the hour allotted, and raise his earnings per hour to 37½ cents. If he take but half an hour, his earnings per hour would be 50 cents. It is fair to say, however, that very large savings of time are not contemplated, since the study made is with a view to fixing the highest possible rate of production, taking into account the permanent well-being of the workman. Every possible aid, such as personal attention of his foreman and keeping his machine and tools in the best possible condition, is given him to help him toward the attainment of the time set, and therefore the earning of the bonus. The curve marked "Gantt" is characteristic of the result. The hourly earnings up to a saving of one-half time are better than under any of the other plans; beyond that straight piece-work gives more pay. If more time is occupied than was set, the results for the workman are the same as under all of the other plans. If the time set is reached it is better, in that the workman then receives the bonus of 50 per cent., while under all of the other plans he must save time to receive any, and then only a relatively small bonus unless the time saved is considerable.

It may fairly be assumed that savings or losses of over one-half of the time set will be infrequent; in considering the relative values of the various methods of wage payment, those giving the higher returns within these limits will be the better. In order to mark off graphically the outlying possibilities, dotted lines have been entered on the diagrams from time savings and losses of one half.

While Diagram 1 gives the possibilities of earnings per hour under various systems in direct amounts for a 25-cent base rate, Diagram 2 shows their relative value dissociated from the actual amounts. The arrangement is similar to that of Diagram 1, but a vertical scale of ratios has taken the place of the actual amounts. The returns of the day-pay plan have been taken as the unit of comparison. A glance shows that the Gantt and piece plans are decidedly productive of the

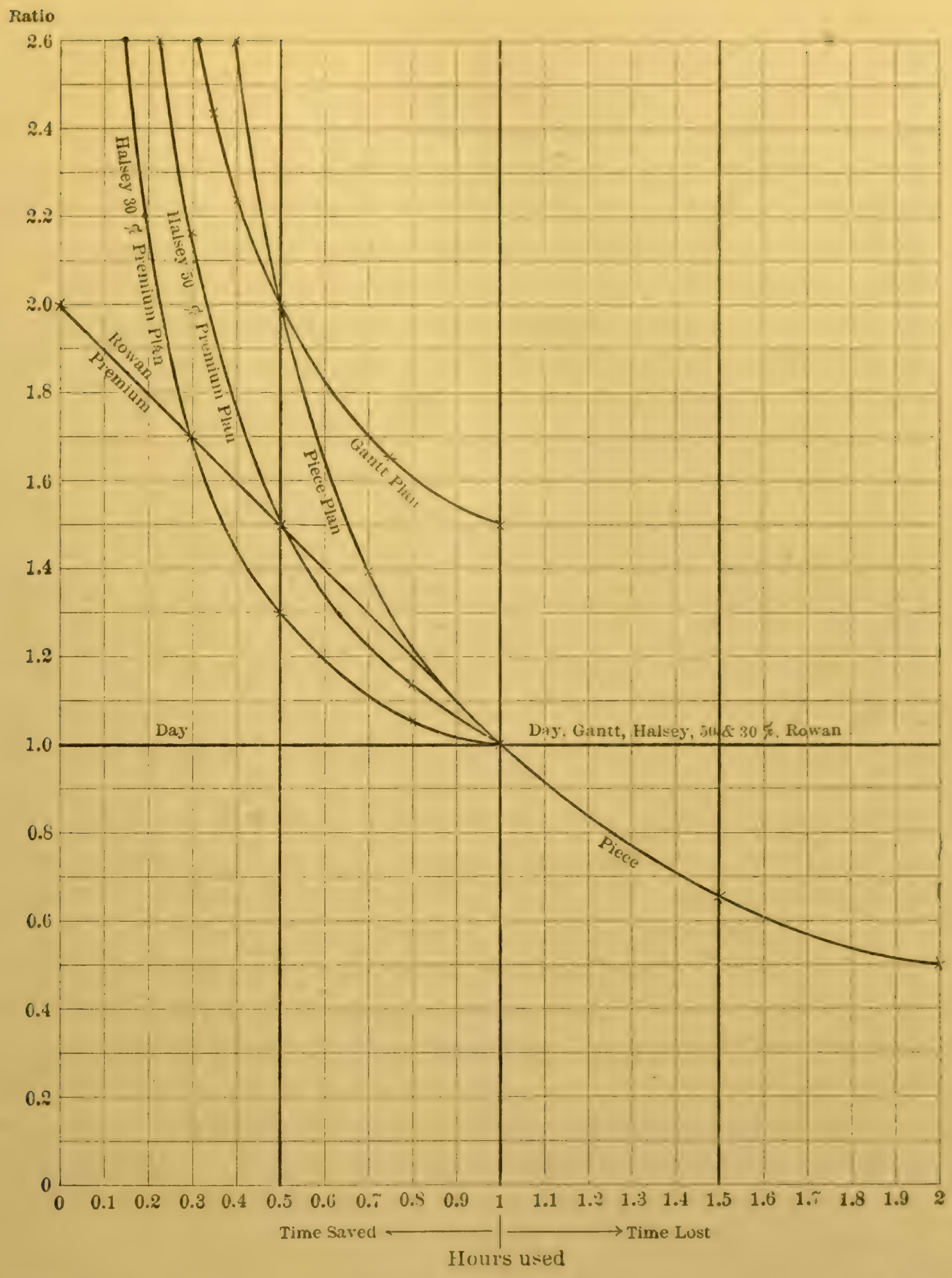


DIAGRAM 2. RELATIVE VALUE TO THE WORKMAN OF VARIOUS METHODS OF WAGE PAYMENT, AS COMPARED WITH DAY PAY.

greatest wage return for time saved; the piece plan involves a loss should the workman for any reason find himself unable to accomplish his task in the time set; the Gantt plan liberal as to the bonus for attaining or bettering the time set is by far the more productive. The ordinary piece plan is fully twice as valuable as the

50-per cent. premium and the Rowan plans when half time is saved, and over three times as valuable as the 30-per cent. premium plan. For lesser time savings its relative value is not quite so great; the Rowan plan most nearly approaches it under such conditions. For those relatively rare possibilities or exceptional workmen that attain time savings of more than one half, the Rowan plan becomes relatively less and less valuable to the workman, and the straight piece plan the best.

Considered purely from the standpoint of the possible returns per hour, the Gantt and the piece plans are seen to be big with the greater possibilities of gain for increased effort. If nevertheless the unions distinctly favor day work, as many do, that is probably owing to the fear that the high wage returns offer a temptation to "cut the rate" that the average employer cannot resist. More than likely the penalizing involved by the piece plan for slower workers also has its influence. If some one or other of the premium plans finds favor it is undoubtedly as a compromise between the fear of a cut on the one hand and a desire of the more progressive and active men to get the returns they know to be possible: The merit of having originated quite an ideal compromise is Mr. Halsey's, in the guarantee it presents of an unchanging base rate and a least hourly wage; it is not at all surprising that this plan and its modifications find more and wider acceptance as they become more generally known. Though of American origin and possibly used in the United States in more individual establishments, England has been more productive of modifications and has been first to give official sanction to the plan at a conference between the executives of the Engineering Employers' Federation and of the Amalgamated Society of Engineers, representing the employers and the unions.

Two other modifications of the Halsey plan deserve at least passing mention. Their originators take the ground that it is not equitable that a workman who for any reason is employed at a lower hour rate should not receive the same total return for his work as his fellow of higher rating, provided he takes the same amount of time for the same "job."

Mr. Isaac Ross, of Leicester, England, therefore provides that half the difference between day pay at the man's hour rate and a fixed piece price be added as a premium to the hourly rate earnings, and the latter only be paid if time is lost.

An Austrian Engineer, Schiller, bases his plan on a similar idea concerning the men having different hourly ratings, and on the further principle that the wage cost to the employer should remain constant for all time savings by all men having the same hour rate. Schiller proposes to ensure this by varying the base time so as to grant the greater time to the man having the lower hour rate; in order to provide a guarantee that the employer shall grant this increase in time, he appeals to the employer's self-interest by slightly reducing the total wage cost when the work is done by men of low hourly rating; to secure the workman's co-operation, this reduction is made small as compared with the opportunity for increased hourly earnings. If no time is saved the time used is paid for at the simple hour rate. For all men having a similar hour rate the Schiller plan gives results identical with the piece plan when time is saved, and with day work when time is lost.

All of the arguments used by the originators of these two latter plans are in justification of the supposed necessity of a varying hour rate; so long as men do the same work it is difficult to see a really good reason for rating them differently; differences in skill or diligence are taken care of by resulting differences in hourly earnings under every one of the various plans first considered, except day work, without resort to such complicated devices as those of Ross or Schiller. The latter's method particularly entails troublesome calculations in the fixing of the sliding-scale time base that will surely create distrust in the shop. Far simpler is the extension to all men on the same individual operation or "job" of the principle advocated by many unions, of an uniform hourly wage rate for a district for all men of the same class.

From the employer's point of view the various wage-paying methods described are not quite so simple; he must take into consideration the effect of the wage cost of his work on the profit or loss of his business, on the total capital he must employ to conduct it, and on the returns as dividends on his capital. The relative influence of the various systems of wage payment from the employer's standpoint will be considered in the next paper. The workman, too, is interested in this other side, since it is but logical that that system of wage payment that is the more advantageous to both employer and employee is certain ultimately to prevail, as it arrays self-interest and the great majority's inherent desire for fair dealing on the same side.

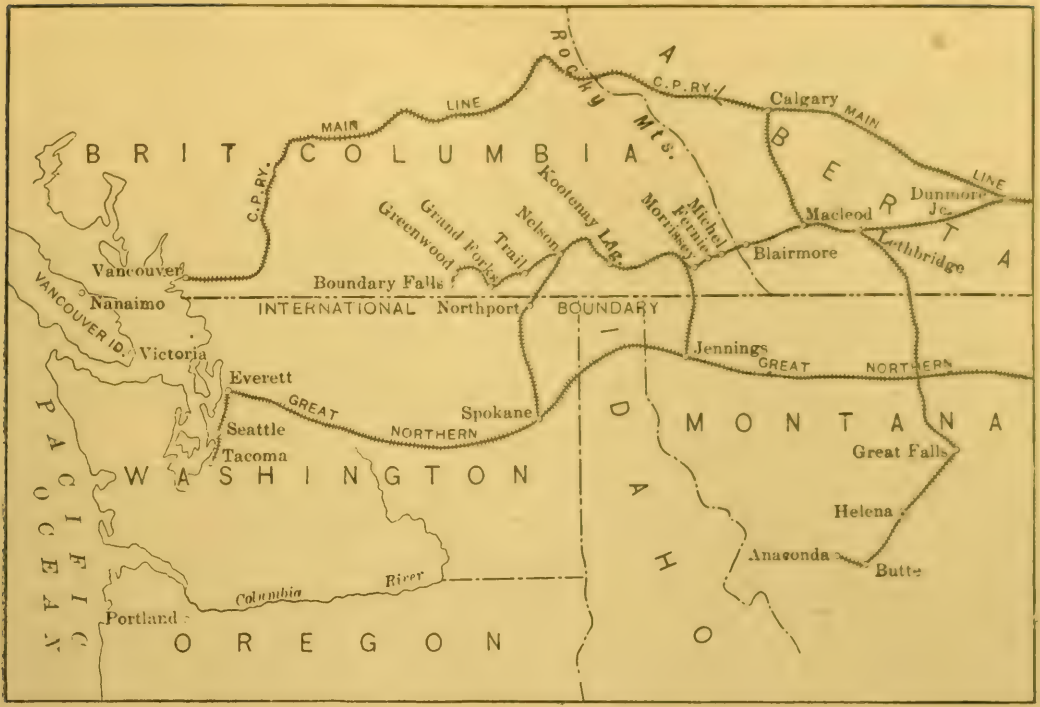
THE COALFIELDS OF CROW'S NEST PASS, BRITISH COLUMBIA.

By E. Jacobs.

The coal deposits described by Mr. Jacobs are destined to play an important part in the mining and industrial development of the Pacific coast—a development which is intimately connected with the fast-making history of the Far East. Mr. Jacobs writes from intimate personal knowledge, and gives a brief but definite outline of the industrial, mining, and mechanical aspects of the field.—THE EDITORS.

THE mining industry of the Pacific Northwest has already attained to considerable proportions and its products are steadily increasing in aggregate value. The share British Columbia has contributed to the comparatively large sum representing the value of this realised natural wealth now amounts to about $210,000,000. Of this total about $65,000,000 was derived from the coal mines of the Province, the production of which mines during the last three years, 1901-1903, averaged in value about $5,000,000 per year.

A review of the coal-mining industry of the northern Pacific coast of America, its present proportions and its prospective very considerable enlargement as more capital shall become available for development and adequate transportation facilities be provided, would direct attention to an expansion the extent of which is not generally realised. But the subject is quite too wide and altogether beyond the scope of this present article. Numerous coal-bearing districts have been discovered in Alaska, on Pacific coast islands, on the mainland of British Columbia, and in the State of Washington. In some of these coal fields, notably on Vancouver Island and in the Crow's Nest Pass region of British Columbia, and in others in parts of Washington, there have been opened up important coal mines now equal to a combined production at the rate of between 4,000,000 and 5,000,000 tons of coal per annum. Of these, the Crow's Nest Pass mines, which are expected to produce in 1904 at least 1,000,000 tons, give promise of becoming the most important coal mines in the Northwest, first because of the unusually large area and great productiveness of the coalfields in which they are situate, and next on account of the fast-growing railway enterprises and mining and smelting industries in large measure depending upon them for their supply of fuel. It is intended, therefore, on this occasion, to restrict investigation to the Crow's Nest



SKETCH MAP OF THE CROW'S NEST PASS REGION.

Pass coalfields together with the adjacent coal-bearing regions of southwestern Alberta.

The Crow's Nest Pass coalfields are situate immediately west of the summit of the Rocky Mountains and about 375 miles due east from the coast. They are in the Fort Steele mining division, East Kootenay, and are about 40 miles north from the International boundary. In the foothills along the eastern flanks of the Rockies, across the dividing line between British Columbia and Alberta, the coal seams of the Crow's Nest country are repeated. But even this neighbourhood does not mark the limit of the occurrence of coal, for eastward for many miles, at Lethbridge and farther still at Souris, mines are being worked in seams of coal varying in quality and character from the lignites of the southeastern portion of the northwest territories to the bituminous coals of the Rocky Mountains. The coal regions also extend many miles northward, for at Anthracite and Canmore, on the Canadian Pacific main line of railway, anthracite coal has been mined for several years.

Coal is said to have been discovered in this part of the country more than twenty years ago. Its stated existence is alluded to in the Report of Progress of the Geological Survey of Canada for 1880-82 (p. 2 B). It is again referred to in the report for 1882-84 (p. 111 C). The coal-bearing area was approximately defined and examined in a preliminary way by Dr. George M. Dawson in 1883. Later, in 1891, after some of the measures had been prospected, it was visited by Dr. Selwyn, also of the Geological Survey, for *The Mineral Industry* (to the end of 1898, p. 200). Dr. Dawson wrote:

> "This coalfield, although it has not yet been fully defined, must have an area of at least a couple of hundred square miles. There are numerous superposed seams, ranging in thickness from 2 to 30 feet, and although the whole series, supposed to comprise about 20 seams, covers only the central part of the field, it is already manifest that we have here one of the most remarkable coal basins known. Dr. Selwyn roughly estimates the coal underlying each square mile, in one part of the field, at 49,952,000 tons. (Annual Report, Geological Survey, Vol. V., N. S., p. 14 A.)"

The history of the development of the Crow's Nest Pass coalfields dates back to 1887. Three years prior to this Lieutenant-Colonel James Baker, an Englishman (brother to the celebrated Baker Pacha and Sir Samuel Baker) who saw service in the Indian Navy from 1844 to 1850, and later in Her Majesty's army, retiring in 1875 with the permanent rank of Lieutenant-Colonel, settled in East Kootenay. Reports of the existence of coal measures attracted his attention and that of Mr. Wm. Fernie, who was afterwards associated with him in forming a syndicate to develop them, and after whom, in 1897, the town of Fernie was named. Every summer for eight or nine years Mr. Fernie took men from Fort Steele to the Elk River district to prospect the coal measures there. Eventually a company was formed to take over the syndicate's holdings, and a charter authorising the construction of a railway to give access to the coal district was obtained from the Provincial Government, of which Lieutenant-Colonel Baker was by this time a member. But about ten years (1887-97) elapsed before these pioneers achieved their object and began to see a return for all their patient and persistent effort. Their reward came with the closing of an arrangement with the Canadian Pacific Railway Company for the construction of the Crow's Nest railway. Meanwhile the Crow's Nest Pass Coal Company had acquired the coal lands.

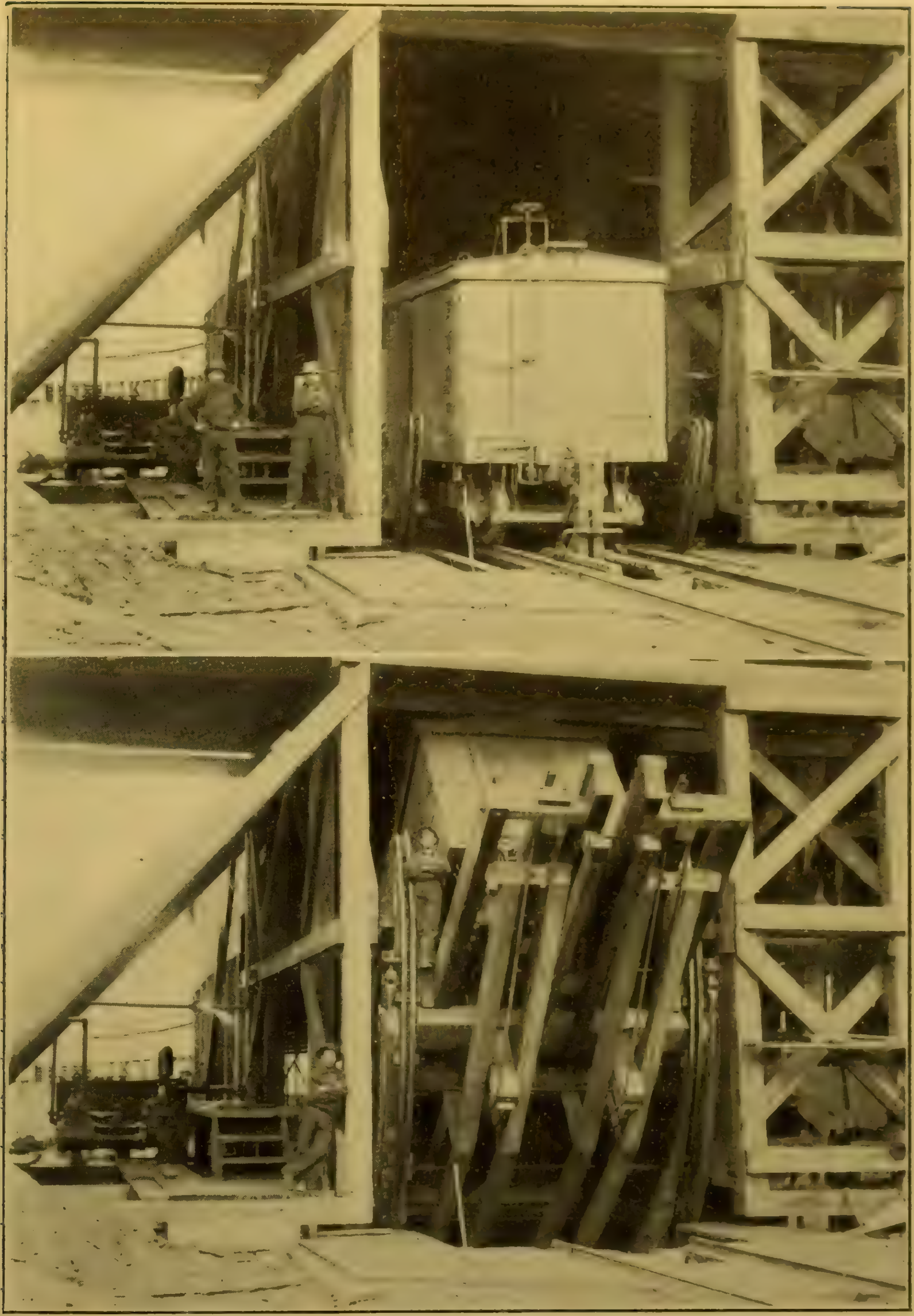
The Crow's Nest Pass Coal Company was incorporated by Dominion charter in 1897. Its authorised capital is $3,500,000, stock to which amount has been issued, the last $1,000,000 in 1901 at a premium of 150 per cent. It was formed (among other things) "to mine and extract coal and produce petroleum in the Dominion of Canada." It owns in fee simple a large area of coal lands situate on the east side of Elk River, one of the streams draining the East Kootenay district. Its first coal-mining operations, commenced in 1897 were at Coal Creek.

By the time the railway reached this colliery, in the autumn of 1898, there were 8,000 or 9,000 tons of coal on the dump awaiting shipment. The Coal Creek colliery is situate about four miles east of Fernie, a prosperous town established on Elk River by the Coal company, its 3,000 inhabitants being supported chiefly by the coal-mining, coking, and lumbering industries of the district. Later other mines were opened, first at Michel, 23 miles by rail nearer to Alberta, and next at Morrissey Creek, 13 miles by rail in the opposite direction.

At Coal Creek colliery there are six mines on four seams all of which have a north and south strike and a dip to the east of about 15 degrees. The largest of those is a 30-foot seam of soft coal. Coal Creek valley here is about 900 feet from bank to bank, and a high trestle affords convenient connection between the mines on one side and those on the other. The railway runs under the bridge, there being five separate tracks for the cars by which the coal is shipped. There are two tipples here, and other plant in keeping. At Michel there are six producing mines in active operation and two others being opened up. Six seams are being worked on the south side of the valley of Michel Creek and two on the north. Here, too, the valley, which is about 1,100 feet wide, is bridged, and there are four separate railroad tracks on which to load coal for shipment. At Morrissey Creek there are five mines in operation, all on the north side of the creek and each on a separate seam of coal. The coal on the south side of the creek is under separate ownership, and is not yet being worked. The Morrissey colliery, in addition to having an up-to-date plant in other respects, has included in its equipment an automatic box-car loader, the only one of its kind in British Columbia, and one of the very few in use anywhere. Being an entirely new departure in engineering in this connection, it is one of the most interesting features of the equipment of the Crow's Nest Pass collieries.

In the operation of this loader the box cars are run onto a tilting platform and securely locked thereon. One end of the platform is then tilted down and the coal allowed to run into the car until the lower half is loaded. The car is then brought back to a horizontal position and, whilst the coal is still running in, it is slowly tilted in the opposite direction. The tilting is continued up to the maximum of about 35 degrees at which the car is held until fully loaded. By exercising care in tilting the second end very little of the coal from the end first loaded will run down when the unloaded end is lowered for tilting. The platform is supported by vertical sides each of which is a sector of a circle, the centre being 8 feet above the track and the arc 150 degrees long. The combination of platform and sides is called the cradle. These semicircular sides have tires or rims of railway T rail and are supported by cast rollers. These rollers, two on each side of the cradle, are spaced 60 degrees apart, 30 degrees each side of the vertical. On each side of the cradle and tangent to the semicircular rim at the bottom is a horizontal hydraulic cylinder which is movable longitudinally and has each end attached to the opposite side of the rim by a wire rope which circumscribes the rim from the bottom to near the top, were it is attached. By means of a moderately high pressure pump and a four-way cock, water is forced into corresponding ends of the cylinders and allowed to escape from the other ends. The cylinders thus travel longitudinally and by means of the wire rope cause the sides of the cradle to roll upon the supporting rollers and the platform to tilt. To handle box cars of 80,000-pounds capacity requires a water pressure of 250 pounds per square inch, the cylinders being 13 inches diameter. The device is both ingenious and thoroughly effective. It is singular in that it provides for placing the car in the machine instead of the machine in the car as other contrivances previously invented had done.

A detailed description of the mines of these several collieries would require more space than is available here. With one exception the system followed in them is the pillar and stall, worked in panels, but the coal is conveyed in chutes from the faces to the gangways, where the mine cars receive it. Main haulage at Coal Creek is in some of the mines by electric locomotives and in others by main and tail rope. At both Michel and Morrissey it is by rope, with steam locomotives outside the mine workings. Secondary haulage at all three collieries is by either electric or compressed-air hoists, with horses or mules wherever these can be used to advantage. To provide room for handling the increasing output of coal and for better ventilation, these mines being gassy, the company has introduced the three-entry system—that is, a main and two parallels—in all new mines, instead of the two-entry adopted in mines they opened earlier. Ventilation is by fans, all the later installations being of large fans designed by Mr. W. R. Wilson, formerly general manager for the company. These fans are reversible, for either forced or exhaust draft. Here they are worked as exhausters. They are of a capacity of 250,000 cubic feet of air per minute. The following are instances of the conditions under which they operate: One at Michel, of 8-feet face and 16-feet diameter, discharges 95,000 cubic feet at water gauge 1.4-inch. It is driven by a 16 by 18 Erie City side-crank steam engine; speed of engine 60 revolutions and of the fan 104 revolutions. One at Coal Creek, 12-feet face and 16-

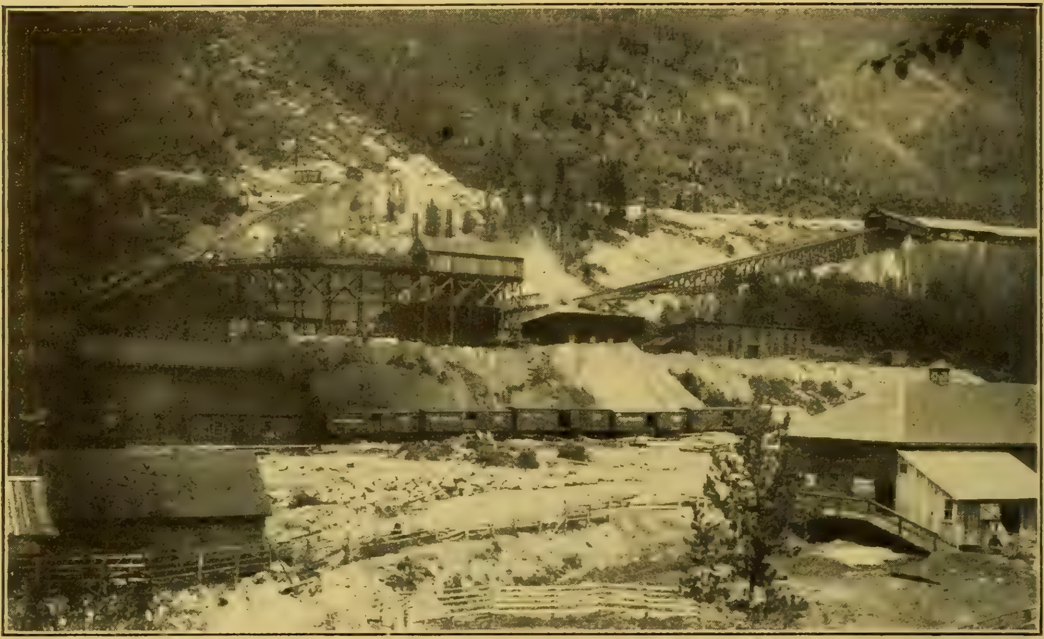


GRAVITY HYDRAULIC BOX-CAR LOADER, MORRISSEY COLLIERY.

The invention of Mr. S. Kedzie Smith, C. E., now of Billings, Montana.

feet diameter, discharges 150,000 cubic feet at water gauge 0.9-inch, and one at Morrissey, 8-feet face by 16-feet diameter, discharges 120,000 cubic feet at water gauge 1.5-inch.

The arrangements for screening, sorting, and loading the coal on railway cars comprise main tipples with Phillips' automatic cross-over



SURFACE WORKS AT MORRISSEY MINES. TIPPLE AND BOX-CAR LOADER BUILDING ON EXTREME LEFT.

car tips; chutes fitted with double sets of screens for screening and sorting coal, which is shipped as "run-of-mine," "full-screen" and "full-screen and nut," and Link Belt Engineering Company's picking tables, operated by rope transmission, for dry-cleaning. No washing is necessary, there being very little dirt with the coal.

At Michel the slack coal is collected in pockets, conveyed to an elevator, and discharged on a second conveyor which distributes to the slack bunkers as required. These bunkers have a total holding capacity of 3,000 tons. At the other collieries the conditions necessitate a departure from ordinary methods, for owing to there not being room in the valleys for a sufficient number of coke ovens these are built away from the mines (the Coal Creek ovens are at Fernie and the Morrissey ovens a shorter distance from the mines) and the slack is loaded directly onto railway cars and hauled to big slack-storage bins erected near the ovens.

The coke ovens are of beehive shape, diameter 12 feet, and have a circular "eye-hole" or chimney at the top. They are built in double rows, of fire brick, with supporting walls and piers of stone masonry filled in between with fire clay. Double-side-discharge steel larry cars charge the ovens with 6½ tons of slack each. The cars are hauled by light standard-gauge steam locomotives. The production of coke per charge is from 3.90 to 4.22 tons, this being at the rate of 60 to 65 per cent. of the charge. The time of burning is 60 to 72 hours, which gives a daily production per oven of 1.3 to 1.6 tons. No provision is made to recover the bye-products. The coke is cooled and the dirt washed off by hose-watering inside the ovens. Thus treated it contains less moisture when drawn from the ovens onto the shipping wharves. The coke is generally long, lustrous, and firm, containing up to 94 per cent. fixed carbon, 4.50 per cent. ash, and 0.75 per cent. sulphur. There are 424 ovens at Fernie, 464 at Michel, and 240 at Morrissey, together 1,128 ovens. These are easily equal to a maximum daily production of about 1,500 tons. A considerable number of the Michel and Morrissey ovens were only recently completed.

The approximate producing capacity of the several collieries when they were visited last January was a follows:—Coal Creek, 1,300 tons Michel, 1,500 tons, and Morrissey, 900 tons; total 3,700 tons per diem. A steady increase on this output is being made as development proceeds. The total output for six years was as under:

Year.	Coal.		Coke.	
1898	8,986	tons.	361	tons.
1899	116,200	"	29,658	"
1900	232,345	"	72,810	"
1901	425,457	"	125,085	"
1902	441,236	"	120,777	"
1903	661,118	"	167,739	"
Totals	1,885,342	"	516,430	"

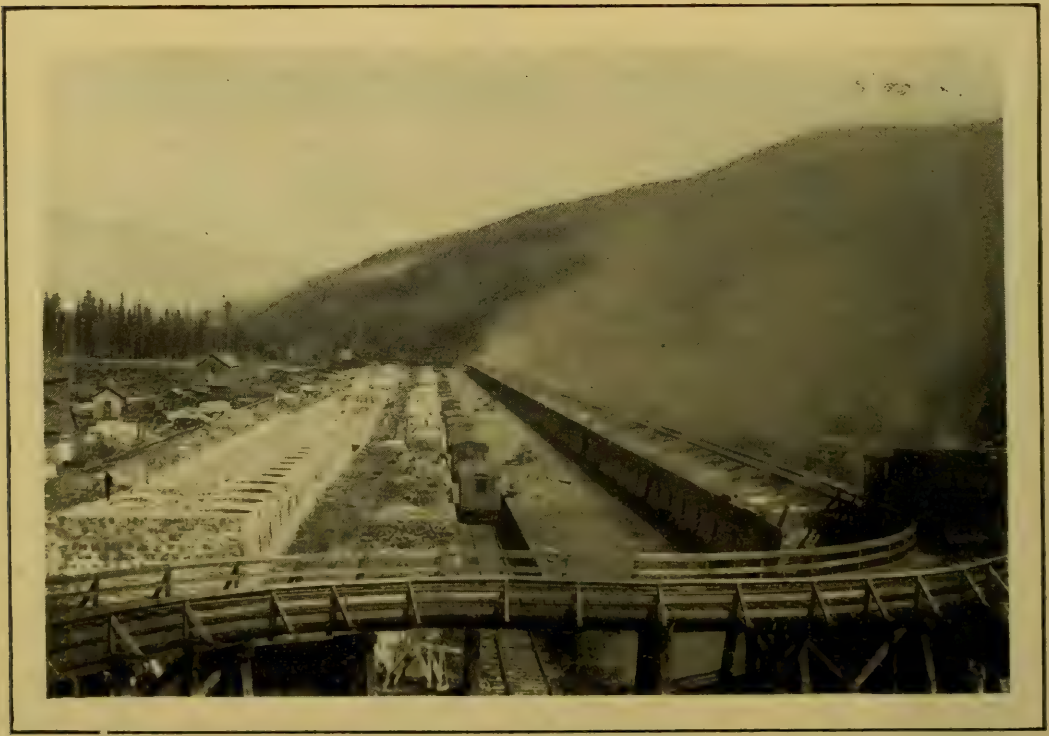
COAL CREEK MINES, FERNIE, B. C. THE SURFACE WORKS.

Of the foregoing gross output of coal nearly 1,000,000 tons (less what has been used under the collieries' boilers) have been sold and the remainder made into coke. The output for 1902 was unfavourably affected by a series of adverse circumstances, the most serious of which were a disastrous explosion which wrecked two of the most productive mines at Coal Creek, and labour troubles at all three collieries. The proportion of total output for 1903 contributed by each of the three collieries was as follows:

Colliery.	Coal.	Coke.
Coal Creek mines	242,673 tons.	94,441 tons.
Michel mines	263,590 "	72,598 "
Morrissey mines	154,855 "	700 "
Totals	661,118 "	167,739 "

The coal exported to the United States in 1903 amounted to 162,952 tons. Of the remainder of the year's total production about 280,000 tons went to the coke ovens and 218,000 tons were sold in Canada. There were 31,089 tons of coke exported to the United States and the remainder of the total quantity produced was sold in British Columbia.

The average number of men employed at the company's collieries



COKE OVENS BUILDING AND IN OPERATION AT MICHEL.
Locomotive and larry cars to the right. Box cars at wharves in center.

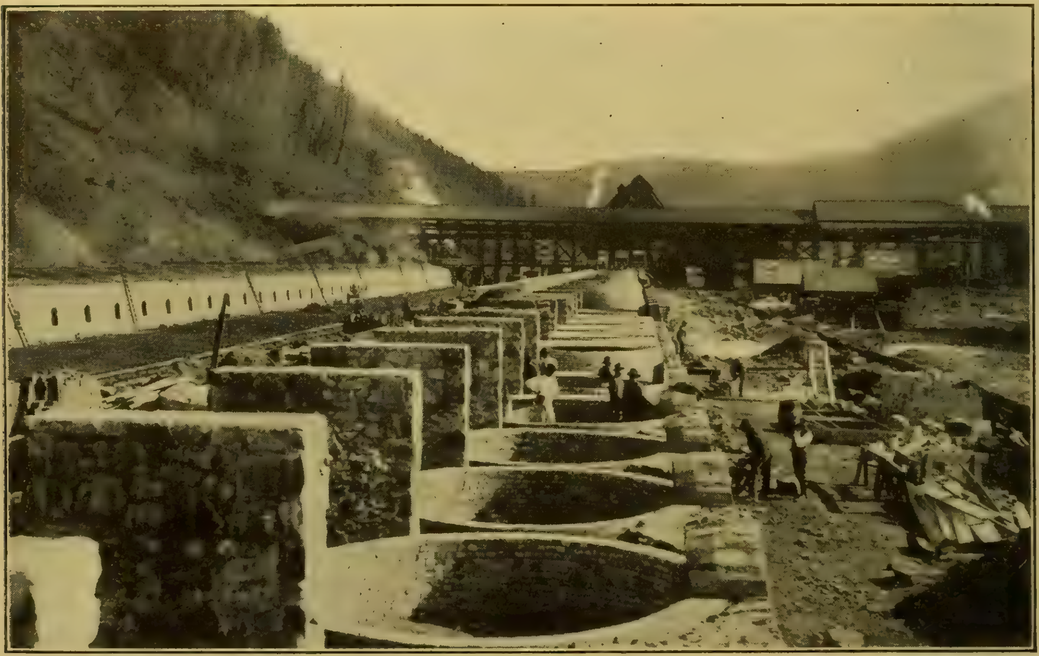
COAL CREEK COLLIERY. COKE OVENS AT FERNIE.

in 1902 was 984, and in 1903, 1,450. About the middle of last December the number of the company's payrolls was as follows:

	Miners.	Oven men.
Coal Creek colliery	427	117
Michel "	583	105
Morrissey "	291	25
	1,301	247

Miners, as above	1,301
Men on general construction work	250
Management, engineering and clerical	37
Total	1,835

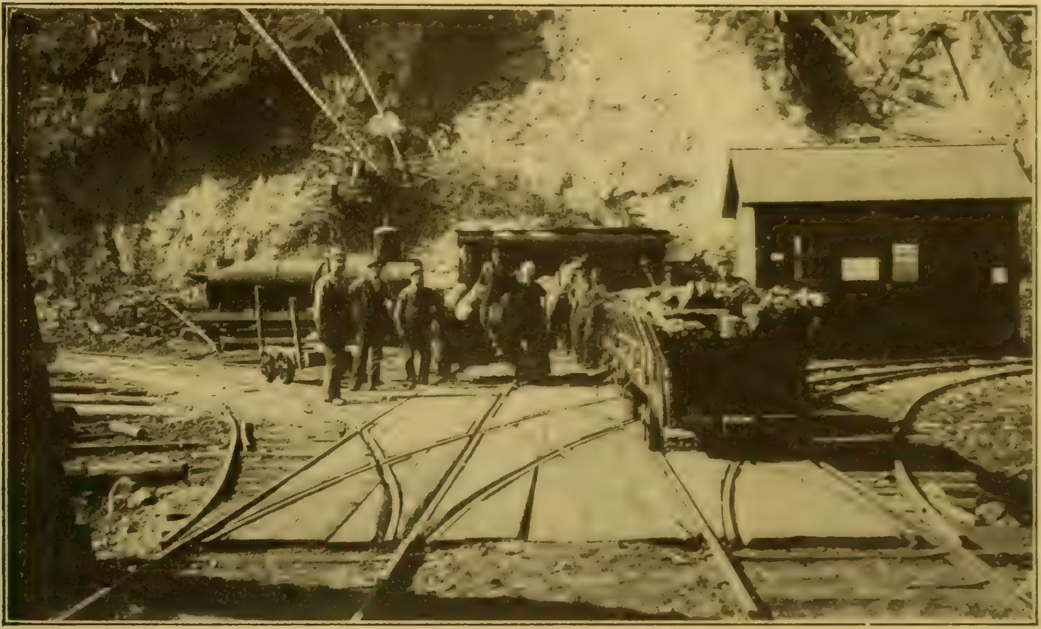
The Dominion Government and the Canadian Pacific Railway Company both hold valuable coal lands in the Crow's Nest Pass country, and the latter has done development work in several parts of the fields with a view to eventually producing coal. There are besides large areas owned by individuals or organisations, but so far no work of importance has been done towards making them productive. In the Blairmore-Frank district, though, there are several companies at work. The pioneer company was the Canadian-American Coal & Coke Company, which has been working a mine at Frank for several years. The West Canadian Collieries Company is a consolidation of several properties previously operated by either companies or private firms. This consolidation comprises the Grassy Mountain, Lille, Belleview and Proctor-Fishburn-Baker coal lands. Quite recently the International Coal & Coke Company acquired valuable coal lands at Coleman, near Blairmore, and mines are being opened up, coke ovens built, and railway shipping facilities provided with the object of reaching a daily production of at least 1,000 tons of coal before the current year shall close. This company is preparing to supply coke to the Granby Company for its smelter at Grand Forks, Boundary District. There are other coal properties that have been more or less prospected, but the more prominent in the district are those above-mentioned.



BUILDING COKE OVENS AT MICHEL.

Two railways give the Crow's Nest Pass coalfields access to markets for their coal and coke. The Canadian Pacific Railway Company's Crow's Nest line leaves its transcontinental line at Dunmore Junction, Alberta, reaches Lethbridge at 107 miles, Coleman at 202 miles, Michel at 224 miles, Fernie at 247 miles, Morrissey Junction at 256 miles, and Kootenay Landing at 394 miles. From Kootenay Landing to Nelson the distance is 52 miles, of which distance 32 miles, to Proctor, is by water, the freight cars being transferred to large scows or barges each carrying ten cars. Smelting points in British Columbia reached by C. P. R. are distant from Fernie, where are the coke ovens of the Coal Creek colliery, as follows:

Nelson, West Kootenay	199 miles.
Trail, " "	251 "
Grand Forks, Boundary	295 "
Greenwood, "	317 "
Boundary Falls, "	321 "



MAIN ENTRY TO MINES NOS. 3, 4, AND 5, MICHEL COLLIERY, SHOWING TRACKS TO OTHER MINES.

The distances from Morrissey, colliery ovens, to which a four-mile spur runs from Morrissey Junction, are five miles less than those given above, whilst from Michel they are thirty-two miles more. From Fernie east to Lethbridge the distance is 140 miles, or from Michel 117 miles. From Lethbridge to Montana smelting points the distances are as under:

To Great Falls	215 miles.
" Helena	314 "
" Butte	387 "
" Anaconda	413 "

Connection is made with these several points over the Great Northern Railway Company's Great Falls and Sweet Grass line. Fuel shipped from Frank, Blairmore, or Coleman, all in southwestern Alberta, would have to be transported 89, 91 or 95 miles, respectively, from those points to Lethbridge.

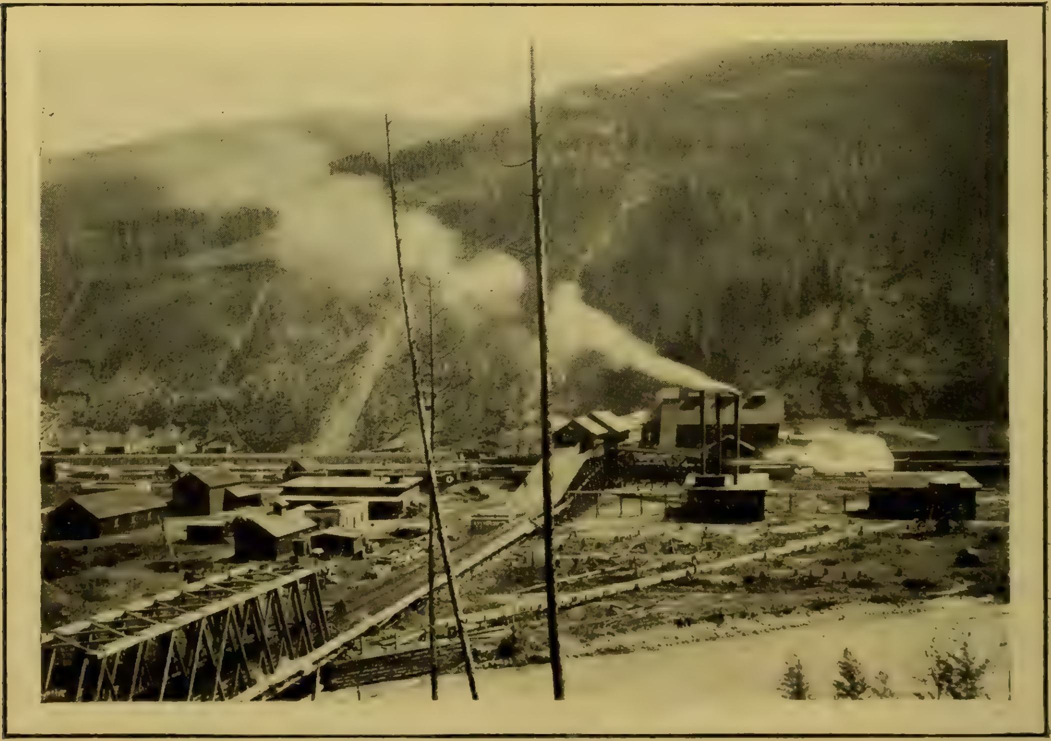
The Great Northern taps the Crow's Nest Pass coalfields on their western side by its line from Jennings, Montana, to Swinton, British Columbia, at the latter point connecting with the C. P. R. at Morrissey

Junction, one mile, and Morrissey mines, five miles. The distances from Jennings to the several collieries are:

To Morrissey Colliery		104 miles.
" Coal Creek "	(Fernie)	114 "
" Michel "		137 "

Jennings being on the Great Northern's transcontinental line the foregoing mileage will serve to show the distance coal has to be hauled to reach that line. The Great Northern also has a road from Spokane, Washington, north to Nelson, B. C. Coke is obtained from Morrissey for the smelter at Northport, Washington, a few miles south of the International boundary. If hauled via Jennings and Spokane, over Great Northern tracks all the way, the distance is 405 miles, but if taken by C. P. R. to Nelson (194 miles) and thence over the Great Northern Company's Spokane Falls & Northern Railway, the distance is 265 miles. These railway distances are given with the object of showing how the coalfields are situated in relation to railways and smelters, which will be their largest customers for fuel, the former for coal and the latter for coke.

For the purpose of showing exactly the quality of the coals of the Province, a series of analyses were made in 1902 at the Provincial Government Laboratory of 20-pound samples of as many of the work-



SURFACE WORKS AT MICHEL, LOOKING NORTH. COKE OVENS IN BACKGROUND ON THE LEFT.

SURFACE WORKS, MICHEL LOOKING WEST.

ing coal seams as it was possible to obtain reliable and average samples from. In order that these analyses should have commercial value the samples were taken from the mines by the Government mine inspectors, who were instructed to take fair and honest samples of the coal *as it can be mined for shipment*, not selected samples. The results, being on average samples, were somewhat lower than could have been obtained from selected samples, but they indicated an exceedingly high grade of bituminous coals. Those from the Crow's Nest Pass mines were nine in number, and they averaged as follows: Moisture, 0.91; volatile combustible matter, 19.1; fixed carbon, 69.93; ash, 9.83; sulphur, 0.32. The total fuel, i. e., the volatile combustible matter and fixed carbon added together, in these nine samples ranged from 75.38 to 95.55.

The superiority in quality of the coal found in the Rocky Mountains over that occurring farther east is very noticeable. The following table will serve to exhibit the transition from lignite to bituminous coal:—

	Rocky Mountains		Alberta.	
	Anthracite.	Blairmore.	Lethbridge.	Souris.
Moisture	0.71	2.07	12.08	16.92
Volatile	10.58	22.84	26.87	38.58
Fixed carbon	82.14	68.35	54.93	40.72
Ash	6.57	6.74	6.12	3.78
	100.00	100.00	100.00	100.00

Mr. James McEvoy, then a member of the Geological Survey of Canada, spent the field-work season of the year 1900 in examining this extensive coal-bearing area. His report on it was published in the Summary Report of the Geological Survey Department for the year 1900 (pp. 85-95), and later the department published a geological and topographical map (Catalogue number, 767) of these coalfields. During the 1901 and 1902 seasons a considerable area of the coal belt, both the Crow's Nest Pass and the Blairmore-Frank fields, was investigated by Mr. W. W. Leach, also one of the Survey Department geologists, and his reports were published in the Summary Reports for 1901 and 1902 respectively. The latter was accompanied by a geological sketch map (No. 808) with cross-sections. All these publications are obtainable at low cost from the Geological Survey, Ottawa, Ontario. The reports are too long to be reproduced here, so only a summary can be given. Mr. McEvoy states that:—

> "The area of Cretaceous rocks in this vicinity is nearly 500 square miles in extent. The coal measures, originally deposited over the whole area, have been eroded away around the edges, where the rocks are crumpled and folded, and along some of the deeper valleys penetrating well into the area, so that their actual area is approximately 230 square miles. In shape, the area covered by the coal measures, like that of the Cretaceous basin itself, is, roughly speaking, a long pointed triangle, with its base to the south. Its greatest length is about 35 miles, north and south, and its greatest width about 13 miles. These figures are of course only approximate. . . . . . The Crow's Nest branch of the Canadian Pacific railway, descending Michel Creek on the west slope of the mountains, crosses the northern part of the coal lands. It then follows the Elk River downward, nearly along the line of the western boundary of the Cretaceous area, for a distance of about 25 miles. The upturned western edge of the Cretaceous rocks forms a ridge or escarpment which runs parallel to the Elk River and three or four miles distant therefrom. The height of the escarpment is fairly uniform, being 3,500 to 4,000 feet above the river. About half-way up the slope the coal measures are found outcropping with dips of 30 to 40 degrees eastwards. . . . . Although in general the Cretaceous rocks are said to have assumed the form of a flat-bottomed basin, there are many places where local faults have destroyed the symmetry of this arrangement. Some of these faults are of considerable dimensions, and form an important factor to be reckoned with in the problem of systematically mining the coal."

In order to obtain an idea of the character and thickness of the Cretaceous rocks occurring in the basin a section was measured on the front of the escarpment, about three miles north of what is now known as Morrissey Junction. The site selected was on a small spur from the escarpment, where, some years before, excavations had been made on

HORIZONTAL STRATA IN CAMBRIAN ROCKS, ELK CANON, SEVEN MILES SOUTHWEST OF MORRISSEY.

Characteristic of the formation west of the coal area.

the outcrop of the coal seams. The crest of the spur has an average slope of nearly 30 degrees. An exceptional opportunity was here afforded of getting an unbroken section of nearly 5,000 feet. The actual thickness of strata measured was 4,736 feet 3 inches and in this there were found to be 24 seams of coal having a total thickness of 216 feet 2 inches. Of these there were two of a minimum thickness of one foot and two of a maximum of 46 feet. Mr. McEvoy observes: "Of the above thickness of coal the greater part, 198 feet, occurs in a thickness of measures of 1,847 feet. . . . Deducting some of the smaller seams, say three feet and under, that could not be profitably mined, it may be safely concluded that there is a total thickness of workable coal of at least 100 feet." Continuing, Mr. McEvoy described the beds above and below the measured section, and gave an estimate of 12,000 to 13,000 feet as the total thickness of the Cretaceous rocks deposited in the area under notice. He made a comparison between three seams occurring in part of the measured section and those then being worked at Coal Creek, distant about seven miles to the

CROW'S NEST MOUNTAIN (7,800 FEET) AND THE SEVEN SISTERS, AMONG THE EASTERN FOOTHILLS OF THE ROCKY MOUNTAINS.

Crow's Nest is a mass of lime rock thrust through the prevailing Cretaceous.

northward. From this he deduced that while there is at Coal Creek a great diminution in size of the intervening beds, the coal seams are fairly persistent. The openings at Michel, 16 miles north of the mines on Coal Creek, expose three seams of coal 15 to 17 feet in thickness, but there was not then sufficient evidence to correlate them with those at Coal Creek. What there was, however, tended to show that some of the seams at least have a greater thickness at Michel than they have to the south.

In the part of the coal lands north of Coal Creek there is no very great area intact, but as there are several points from which the measures can be conveniently worked no excessive underground haulage will be necessary. The coal seams do not reach any great depth, being almost entirely above the level of the Elk River. The measures lying south of Coal Creek, however, occupy a practically unbroken block of country twelve miles or more in width and of somewhat greater length. Along the front, by the Elk River, the beds continue to hold uniform easterly dips and behave in a similar way to that seen on Coal Creek. Morrissey Creek makes a slight indentation in their outline. A section eastward from Morrissey Creek would show that the measures, after first bending to a horizontal position, rise a little and then slope steadily downward until, at a point three or four miles from the eastern edge of the basin, they reach the lowest depth in the whole area. Owing to the depth of the measures here it is doubtful whether this part of the coal can be profitably extracted. For the greater part, though, the conditions for mining are favourable enough. Mr. McEvoy's estimate of the total available supply of workable coal is as follows:

"Total area of coal lands, 230 square miles, equal 147,200 acres.
"One acre with 100 feet of coal would yield... 153,480 tons of 2,240 lbs.
"50,000 acres would yield.................... 7,674,000,000 " " "
"147,000 acres would yield....................22,595,200,000 " " "

Mr. Leach spent part of the season of 1901 in examining Marten Creek and the upper valley of the south fork of Michel Creek. In his published report he mentions that the coal measures outcrop in this valley at a point about 10½ miles from "the Loop" and at an elevation of about 900 feet above the railway. This valley affords a comparatively easy grade for a branch railway and, as it is fairly wide and flat-bottomed, there would be ample room for coke ovens and other neces-

THE EAST LOOP ON CROW'S NEST RAILWAY, AND ENTRANCE TO TUNNEL.

Nearly three miles are travelled to gain less than 200 feet in elevation. The tunnel will improve conditions somewhat.

sary structures. In a measured section of 921 feet 8 inches there were found twelve seams of coal ranging in thickness from 8 inches to 25 feet 2 inches, and aggregating 69 feet 6 inches. A comparison of this section with one measured at Morrissey showed the coal seams to be "fairly persistent, considering the fact that these two points are ten miles apart. The intervening beds, however, show a wider variation with a decided tendency to thin out, in the lower part of the section at least."

Part of the Green Hills area, situate on the east side of the Elk River, commencing about 24 miles above the junction of Michel Creek with the Elk and extending an unknown distance northwards, was also examined by Mr. Leach. Twelve coal seams were noted outcropping along the crest of a ridge in the Green Hills. These seams ranged in thickness from 0.75 foot to 35.5 feet, and gave a total thickness of 89.5 feet of coal in measures aggregating 3,386.5 feet.

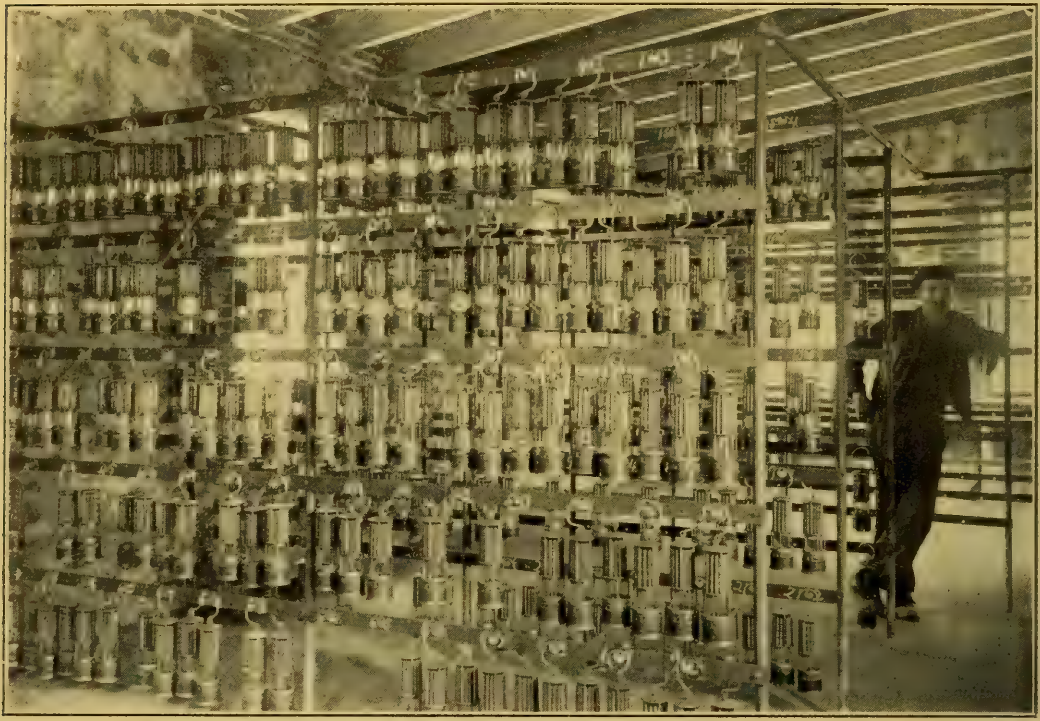
In 1902 Mr. Leach examined the Blairmore-Frank coalfields, which are in Alberta, a few miles east of the summit of Crow's Nest Pass, and are separated from the Crow's Nest coalfields proper by the main range of the Rocky Mountains. To the south they are cut off by the Devone Carboniferous rocks of the Flathead range. To the north the limit of coal-bearing rocks is not yet defined. Eastward the belt of Lower Cretaceous coal-bearing rocks extends about 14 miles from Crow's Nest Lake, when it is overlaid by rocks of Upper Cretaceous and Laramie age, also coal-bearing but to a lesser extent.

In comparing the Middle and Lower Cretaceous rocks of this area with those of the Crow's Nest Pass coalfields, a general similarity is at once seen, with, however, a very marked diminution in thickness in the rocks of this district, especially in the case of the lower dark shales underlying the coal measures. The geological structure of this area is somewhat complex, much faulting and folding being in evidence. Two sections across the coal-bearing rocks were measured. In one, in the northern part of the area examined, twenty-one seams of coal, ranging in thickness from 15 inches to 15 feet 3 inches and giving a total thickness of 125 feet 3 inches of coal, were found to occur in an aggregate of 742 feet of measures. The other section was in the southern part of the area. This section as measured was 479 feet 9 inches and in it there were eleven seams of coal varying in thickness from 3 feet 3 inches to 12 feet, and totalling 101 feet 9 inches. There was very little resemblance found to exist between these two sections, but as the two points at which measurements were made are 23 miles apart, uniformity was not looked for.

Among Mr. Leach's comments were the following:—

> "The coals and lignites of the Upper Cretaceous and Laramie have been opened up in several places, chiefly to supply the local demand for domestic fuel. In most cases, however, the highly contorted condition of the strata renders mining difficult and uncertain. . . . It is now proved without a doubt that very large deposits of coal exist in this area, but success in future mining operations will depend largely on the selection of the best available sites. In this connection several factors have to be taken into consideration, such as the quality of the coal, transportation facilities, the absence of faulting, and the altitude of the coal seams themselves. With regard to the last-mentioned, it is the general opinion among local mining men that, for the present at least, the coal below the level of the valleys cannot be profitably extracted in competition with that won by drifting into the mountain sides and requiring no hoisting or pumping machinery."

In conclusion, too much prominence cannot well be given to the important bearing these coalfields have upon the economic future of the country within a radius of say 250 to 350 miles of them, and possibly over a wider area. Industrial enterprises will for many years be largely dependent upon them for main supply of fuel. A considerable increase in the mileage of railways throughout the country that will draw upon them for the coal is looked for, and that, too, within a few years. As already shown, the main lines of the Canadian Pacific and Great Northern railway systems are within easy reach. The C. P. R. at Calgary (via the Macleod branch) is only 170 miles and at Dunmore Junction about 200 miles from the Blairmore-Frank fields, with no heavy mountain grades between. Michel is but 25 miles farther away, and as the summit of the Rockies, 16 miles east of Michel, where crossed by the Crow's Nest line, is little more than 600 feet higher than the coal mines, the cost of haulage eastward is not prohibitory. The Great Northern at Jennings, on the west of the Rocky Mountains, is but 104 miles from Morrissey, with a grade suitable for heavy train loads; whilst on the east of the mountains, Great Falls, on the same transcontinental railway, is within 300 miles of the the Blairmore-Frank mines, also without heavy grades. Then as to smelting centres:—Great Falls and Helena, two Montana smelting points, are, respectively, about 300 and 400 miles distant from the coke ovens, in one direction, whilst to the west Nelson is reached at 200 miles, Trail at 250, and Boundary points at 290 to 320 miles. The growing importance of the smelting industry of the Boundary district was indicated in THE ENGINEERING MAGAZINE last November (p 249). For some time mines and manufactories will also require an appreciably large amount of coal, but the development of the water powers of the country with attendant electrical transmissions must be taken into account as an eventual competitor in this direction. Then, too, there will be a large domestic consumption of coal to provide for, so that markets seem to be assured for the products of the collieries.



LAMP HOUSE INTERIOR, MICHEL COLLIERY.
500 Wolf Safety Magnetic Lock Lamps.

As to cost of coal and coke:—legislative restrictions prevent the Crow's Nest Pass Coal Company from charging more than $2 per ton for "run of mine" coal at the mines, so this will doubtless be the maximum charge, while competition may later bring the price lower. Coke is supplied at $4.25 to $4.50 f. o. b., and freight to Boundary points is $2 to $2.25, so about $6.50 per ton is the cost delivered at the Boundary smelters. Coke from Vancouver Island collieries used to cost $11 delivered at Nelson; now the smelter there gets its coke from the Crow's Nest collieries at a cost not exceeding $6 delivered, so the beneficial influence of the Crow's Nest Pass coalfields has been unmistakably demonstrated by this reduction of nearly 50 per cent. It may be that even lower prices will eventually prevail, for Mr. Wm. Blakemore, M. E., who in 1898 was general manager for the Crow's Nest Pass Coal Company and has since kept in touch with the coal and coke industries of the mainland of British Columbia, writing on this subject in 1902, made these assertions:—

> "At the moment the charge for coal is $2 at the mines, and for coke $4 at the ovens. Effective competition would reduce these figures to $1.50 and $3 and possibly a little lower. The actual cost of shipping one ton of coal need not exceed $1, and will almost certainly be less after allowing for every item of charge. This would give coke at a cost of $2.25 to $2.50, and leave a margin of 50 cents profit on coal and 75 cents on coke, which is at least double the average rate of profit on coal and coke in the Eastern States or in England over the last twenty years."

The managing director of the Crow's Nest Pass Coal Company, when addressing a general meeting of shareholders, told quite a different story, though, and the price of coke was raised from $4 to $4.25 and $4.50.

So far the operations and output of the Crow's Nest Pass collieries have been small in comparison with those of the older coal mines of the United States. Compared with Pennsylvania's output of bituminous coal in* 1902 of 98,947,117 tons, the tonnage of the Crow's Nest, and indeed of the whole of British Columbia, is very small, but for the latter these are the days of small things. Rapid developments and big strides in the march of progress may, however, be confidently looked for, so that by the time these new fields shall have been as long under development as those of the coal-mining State referred to a very different showing will, doubtless, be made.

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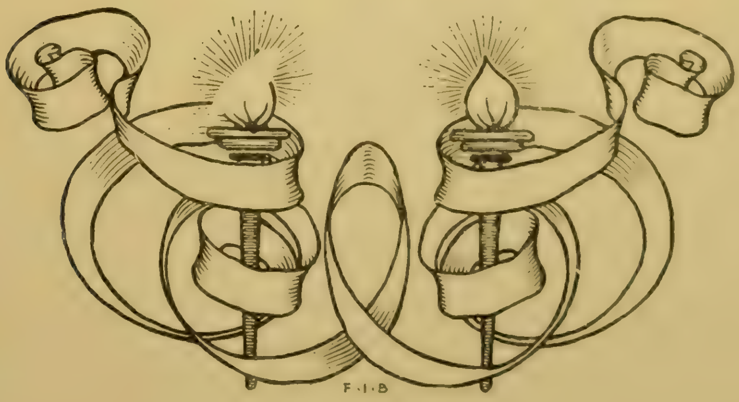
* We are indebted to Mr. F. E. Saward for information that the bituminous-coal output of Pennsylvania for 1903 was about 105,000,000 tons.—THE EDITORS.



THE HYDRO-ELECTRIC STATIONS OF THE ALTA-ITALIA COMPANY.

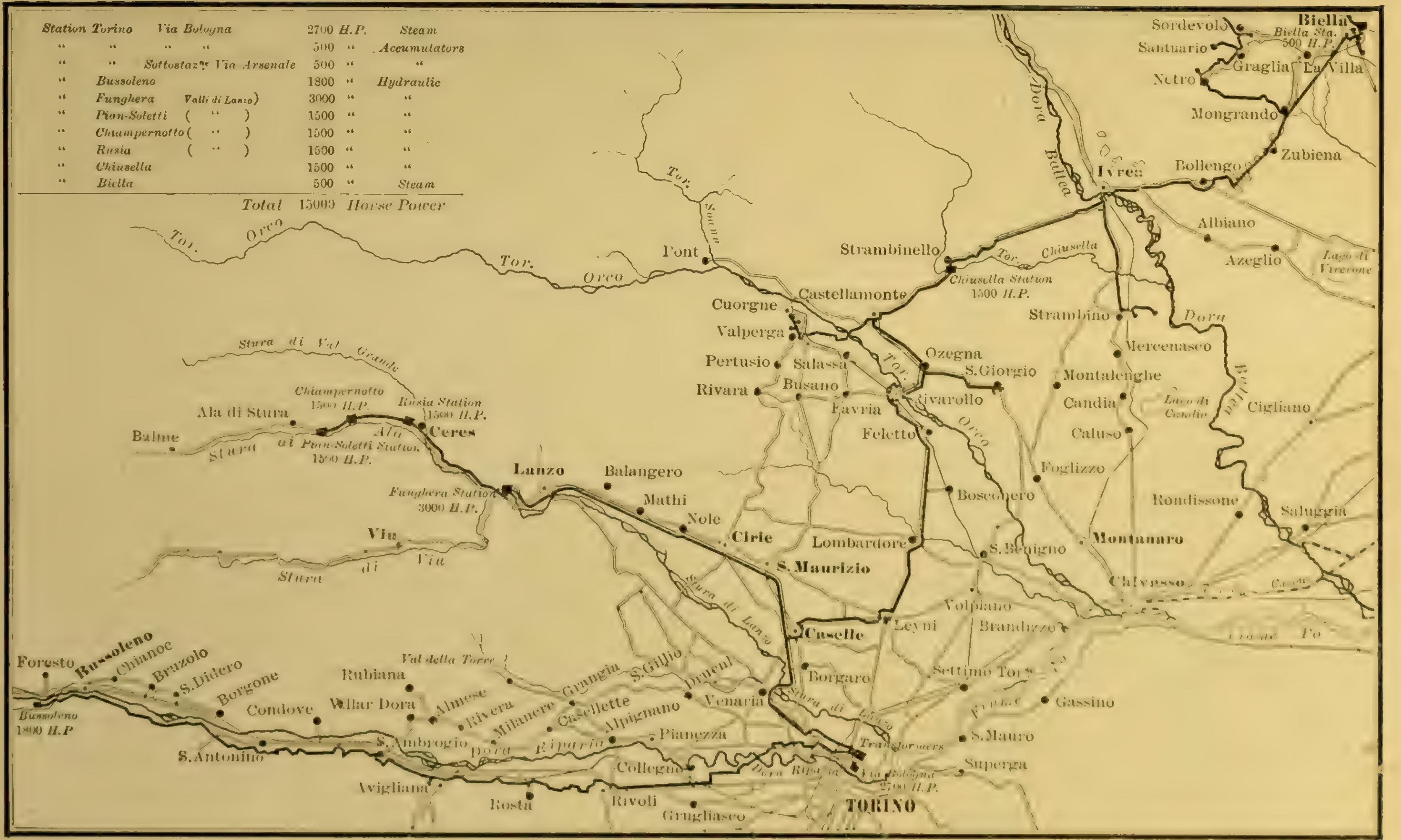
By Enrico Bignami.

AMONG the many important electric enterprises of Italy, one of the most noteworthy is that of the Societá Anonima Elettricita Alta Italia, of Turin, which distributes electric power in Turin for public and private lighting service, for motor installations, and for several tramway lines; and for similar purposes (except as to tramway operation) in many other municipalities within the radius of its distribution network, extending even as far as the town of Biella. The power is generated in the stations of Bussoleno, in the valley of Susa, and of Funghera, in the valley of Lanzo. Three other stations on the Stura between Ceres and Ala supplement the Funghera plant.

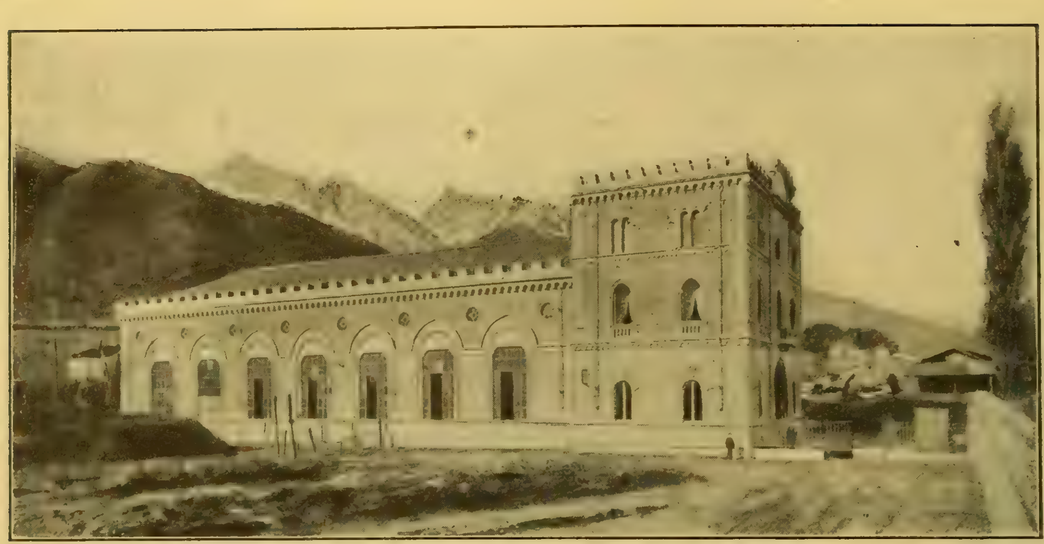
High-tension aerial lines of considerable length carry the power to Turin, that from Bussoleno being about 58.5 kilometres long and that from Funghera about 36 kilometres.

Another large station for the conversion of hydraulic into electric power exists in Piedmont, at a point on the Chiusella called "Ponte dei Preti," near Castellamonte. This station, which also belongs to the Alta Italia Company, supplies light and power to the towns of Biella, Strambino, Cuorgnè, Rivarolo, San Giorgio, and others. The distribution lines from this station to the various points of utilisation, together with the connecting lines from the Bussoleno and Lanzo stations, form a large and very interesting network.

The Bussoleno station is in the valley of Susa, about three kilometres above Bussoleno, on the right bank of the Dora Riparia. From this stream about 6 cubic metres per second are taken, and conducted to the power station through a canal 4 kilometres long and of interesting construction. The difference of level between head race and tail race is 27 metres; from the charging basin the water is taken to the feed pipes of the turbines through two penstocks, each 1.5 metres in diameter and 325 metres long. The turbines—which are installed in a building of great size and very handsome finish—are five in number; three are of 750 horse power each, and two of 120 horse power; they are all provided with oil servomotors for regulation. Each of the three principal turbines is connected by a flexible coupling, to a



SKETCH MAP SHOWING THE HYDRO-ELECTRIC STATIONS AND TRANSMISSION LINES OF THE ALTA ITALIA COMPANY.



EXTERIOR OF THE BUSSOLENO POWER STATION.

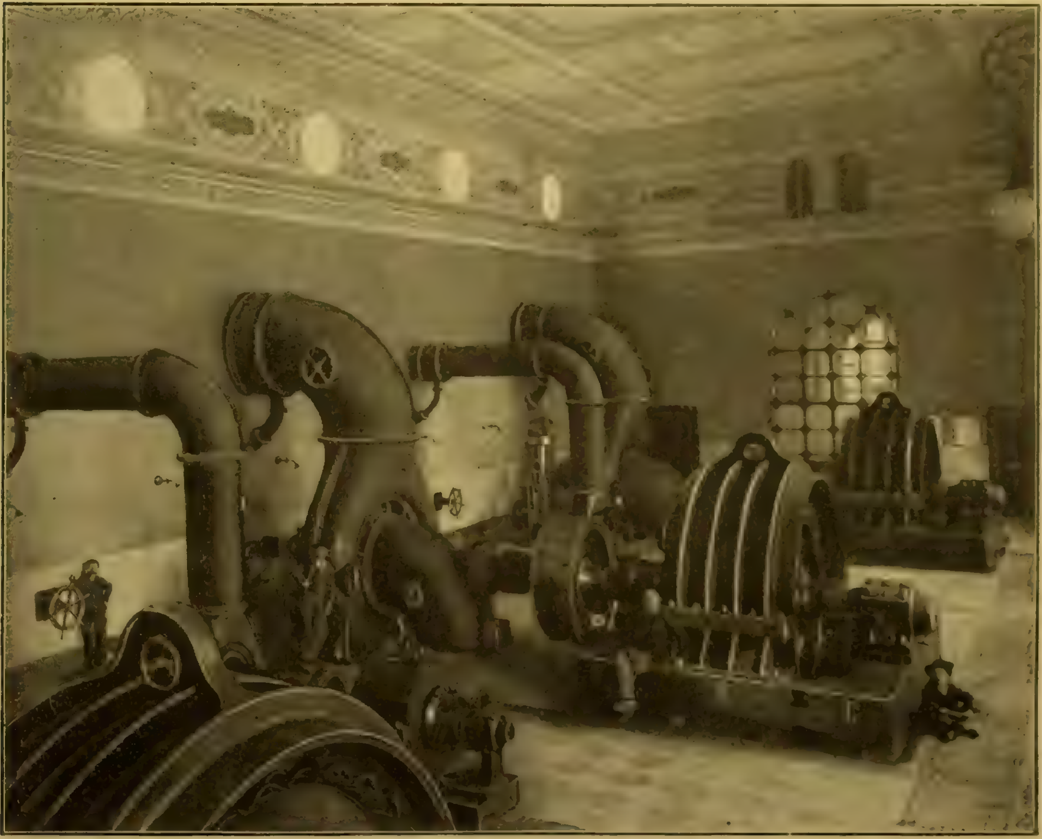
690-kilowatt three-phase alternator of 150 revolutions, 50 periods, with a tension of 450 volts between the phases. One of these groups is held in reserve. The two smaller turbines each drive directly an exciting dynamo of 75 kilowatts at 120 volts, 470 revolutions. Either one of these alone is sufficient for exciting the alternators and lighting the building, the other serving as a reserve.

The current is taken from the alternators to the distribution switchboard, placed at one end of the room on a platform from which the whole plant can be conveniently overlooked. On the front of this board, handsomely panelled in wood, are placed the circuit breakers and the measuring apparatus—wattmeters, amperemeters, voltmeters, and the phase regulators. In this installation, as in other large plants erected by Siemens & Halske, provision is made for controlling the turbine regulators from the switchboard, so that the number of revolutions may be so adjusted as to bring the alternators in parallel and divide the load between them equally or otherwise, as may be desired.

Upon the post which carries the governor arms there is mounted a small direct-current motor, which by means of a bevel-gear transmission and worm gearing shifts the fulcrum of the springs which oppose the action of the governor upon the lever controlling the auxiliary motor, thus enabling the constant of the governor to be varied. Each small motor has independent connections to the switchboard, where special switches are provided, the normal position of these switches holding the circuits open, so that the motors remain at rest. When it is found necessary to shift the springs which act upon the governor lever, the proper switch is moved to one side or the other, and a corresponding motion is given to the small motor.

From the bus bars on which it is collected, the 450-volt current is taken to the step-up transformers. The transformer battery is placed behind the switchboard, and consists of seven three-phase transformers, each of 200-kilowatts capacity, and with a transforming ratio of 450:12,000. Cooling of the transformers is effected by simple natural ventilation. The transmission line however does not now lead directly from the 12,000-volt bars; between are interposed the windings of special transformers, to be referred to more particularly further on, by which the tension is raised to 22,000-24,000 volts.

The switches for the 12,000-volt current are very interesting. They are of the piston type, in which there are two double contacts in series at each pole. Each of these double contacts is composed of two contacts in parallel, of which one (with a large surface) is first broken, without forming an arc; the other contact is broken only after the opening of the first has become sufficiently great, and its point is drawn through a tube of incombustible insulating material, in which the arc cannot follow, the arc being moreover blown out and extinguished by the ascending current of air which its own heat produces in the tube.



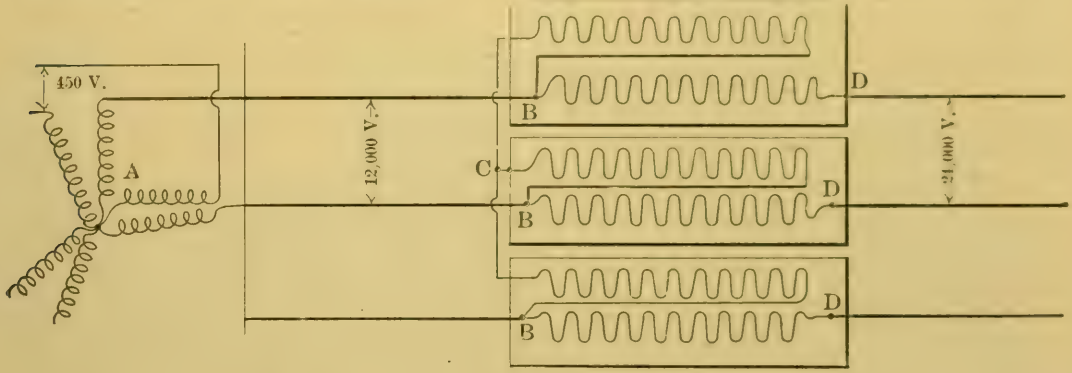
BUSSOLENO POWER STATION, INTERIOR.

From the continuous-current bars supplying the exciters are taken also connections leading from the power station to two motors installed at the charging basin, at the head of the penstocks. These operate gates shutting off the two halves into which the basin is divided, and thus permit the water to be shut off from either or both the divisions of the penstock. The switch controlling these motors is placed on the distributing switchboard. Other small continuous-current motors operate the oil pump for the servomotors, and various machine tools. In connection with the continuous-current bars there is an accumulator battery of 270-ampere-hours capacity. It is used particularly for the incandescent lighting system by which the installation is served.

The current generated at Bussoleno is almost all transmitted to Turin, a few horse power only being taken off for the dynamite factory at Avigliano. It is first transformed to 3,000 volts in a special station; then, in conjunction with the current brought from Lanzo, it is used either for driving the motor-dynamos in the Via Bologna station, where it is transformed into continuous current for the tramway and lighting service in the central part of the city, or, after a second transformation to 120 volts, it is distributed for light and power purposes in the outlying districts.

Turin's demands for electric power being constantly on the increase, the Alta Italia Company decided to enlarge its stations. To the plant at Funghera, near Lanzo, already mentioned, were added three power houses of 1,500 horse power each, utilising the falls of Stura and Ala, between these villages and Ceres. The power supply will be further increased by enlarging the canal at the Bussoleno station so that the power of the large turbines and their connected alternators will be increased to 900 horse power each. The manufacturers have interposed no objection whatever to the disposal, and trials have shown its entire feasibility. In furtherance of this policy of expansion, the Alta Italia Company recognised the necessity of raising the tension of the transmission, so as to avoid the addition of more lines to those already existing—something which would have been expensive to accomplish. The transmission from Bussoleno to Turin will be brought up to 1,800 horse power, and that from Funghera to 6,500 horse power when the Ceres stations are in full operation.

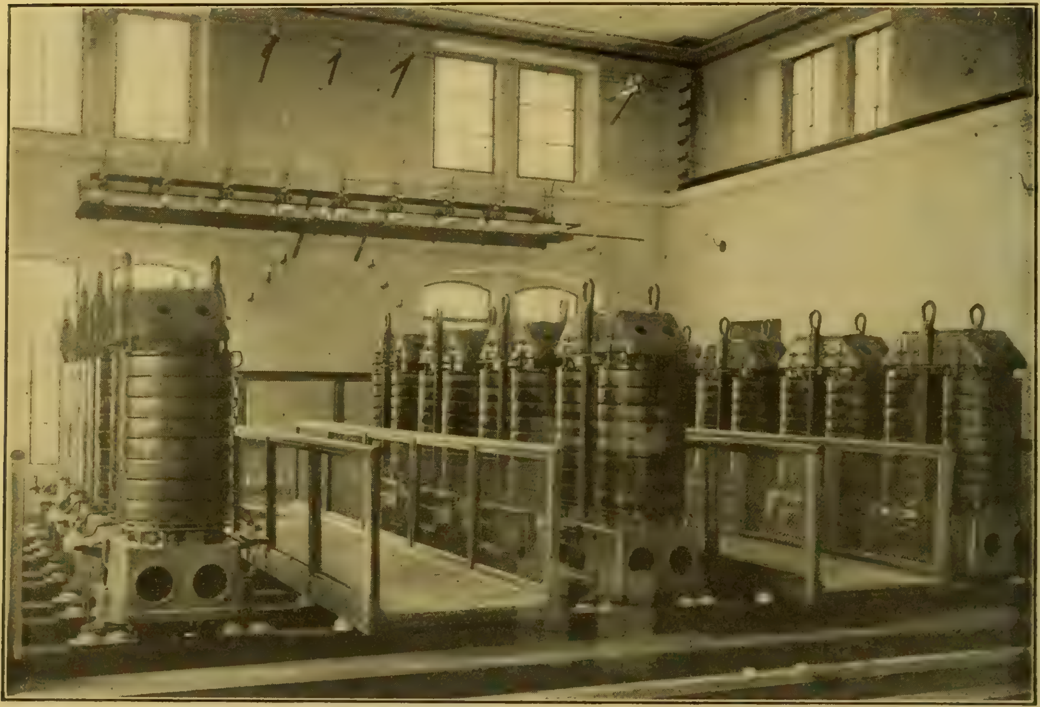
When it became apparent that the tension of the transmission must be increased, preliminary trials were made by doubling the voltage on the Bussoleno installation. New special transformers (now in successful operation for several months) were added to those first installed. The increased tension was obtained without any interference with the operation of the 12,000-volt plant. The 450-volt generators and the 12,000-volt transformers were not disturbed; but the 12,000-volt current, instead of being charged directly upon the line, passes first through the special transformers already alluded to. These are three in number, of 600 kilowatts each, monophase, oil-immersed, and constructed for a transforming ratio of 1 : 1. One of the windings is put in series with the line; the other winding is star-connected at one end to the corresponding circuit of the other transformers, and at the other end is connected with the 12,000-volt line. The arrangement is explained by the diagram. The current from the old transformers, A, when it reaches the terminals B, divides into two parts. One of these follows the circuits BC, the other the circuits BD. The former may be considered as forming the primary of a transformer in shunt with the line, the latter as constituting the secondary winding. Between the terminals B, D, of the latter there will be induced a difference of tension which is to that of the winding BC as 1 :1. But A, the centre of the star of the old transformers, is already at a tension of $12{,}000 : \sqrt{3}$; D therefore will have a tension of $12{,}000 : \sqrt{3} + 12{,}000 : \sqrt{3}$, and the united tension between the two wires will be 24,000 volts.



DIAGRAMMATIC REPRESENTATION OF THE BUSSOLENO AUXILIARY TRANSFORMERS.

The transmission line to Turin, as already stated, is about 58 kilometres long. It is supported on wooden poles, into which are screwed iron pins carrying the insulators. These latter, designed for a tension of 12,000 volts, were not considered safe for 24,000 and it was decided to replace them with others. Careful attention was given to the choice, and after tests the "Karlsbader Kaolin Industrie Gesellschaft" type were adopted. These are made of three petticoats superposed, but separately fired, before they are united in one piece, with the same enamel inside and out, so that in each insulator there are six coats of enamel.

At Turin the current is again transformed to 12,000 volts, by transformers similar to those at Bussoleno, just described, but so modified in arrangement and so wound that the electromotive force of the induced current is in opposition to that of the line and the voltage is reduced to 12,000. It is then further reduced to 3,000 volts by the transformers of the old installation, and finally to 120 volts and converted into direct current.



TRANSFORMER STATION, TURIN.

The proved success of the method as shown at Bussoleno determined the adoption of the same plan at the Lanzo plant, and the change is just about completed. All the electric appliances and machinery have been supplied by Siemens & Halske, and the turbines and governors by Riva, Monneret & Co., of Milan.

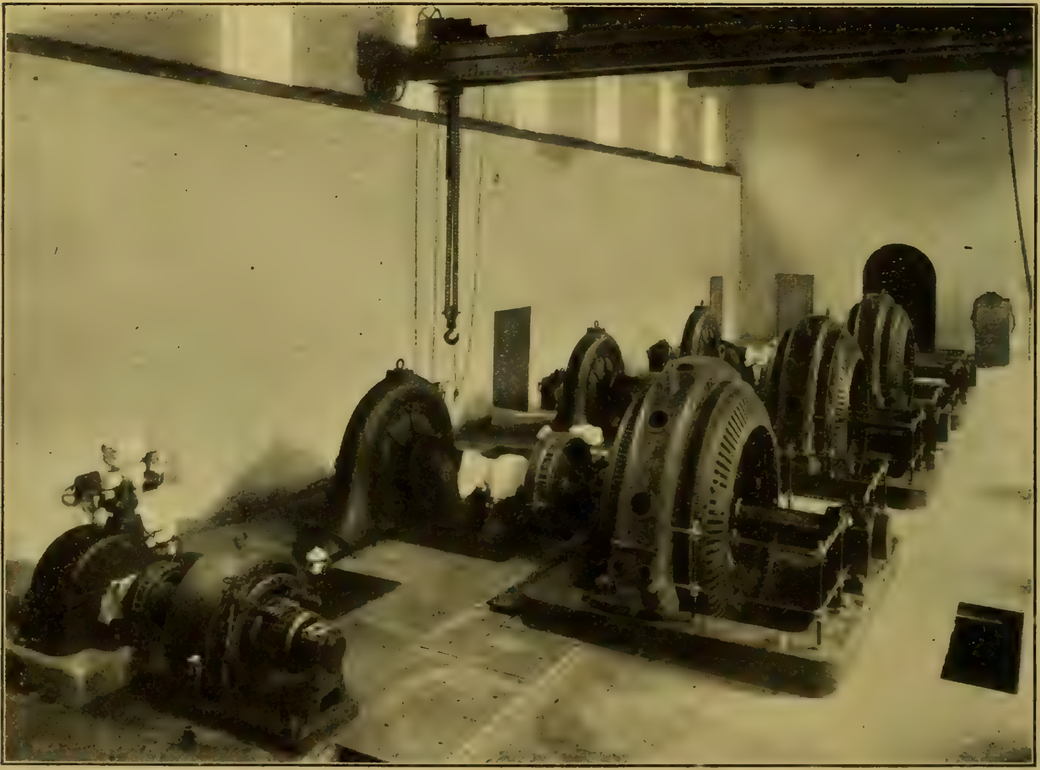
The Ceres Plant.—On the Stura de Ala, between Ala and Ceres, hydraulic power to the extent of about 4,500 horse power is now utilised. It is obtained from a fall of a total height of 315 metres, divided into three cataracts of approximately equal height. Covered canals having a combined length of 7 kilometres convey the water from the intake on the river, just below Ala, to the first of the power stations —Piansoletti—and thence in turn to each of the others—Chiampernotto and Rusià—finally discharging it into the river below the last station. The three plants are all on the right bank of the river and all alike, both as to the buildings and the mechanical equipment.

The view of the Chiampernotto station shows their general character, and the engraving on page 66 the turbine and electrical installation. Each of the installations comprises three turbines of 750 horse power at 375 revolutions and two of 75 horse power at 600 revolutions, all being by Riva, Monneret & Co. To each of the larger turbines is direct-connected a three-phase alternator capable of developing 700 kilowatts at 13,250 volts. These alternators are noteworthy not only for their high peripheral speed (38 metres per second) and for the high tension attained in a power unit of moderate size, but further for their constructive details; the ventilation is especially good. One alternator in each station is in reserve. For excitation there are in each plant two four-pole dynamos of 50 kilowatts at 110 volts, direct-coupled to small turbines.

THE CHIAMPERNOTTO STATION, CERES HYDRO-ELECTRIC INSTALLATION.

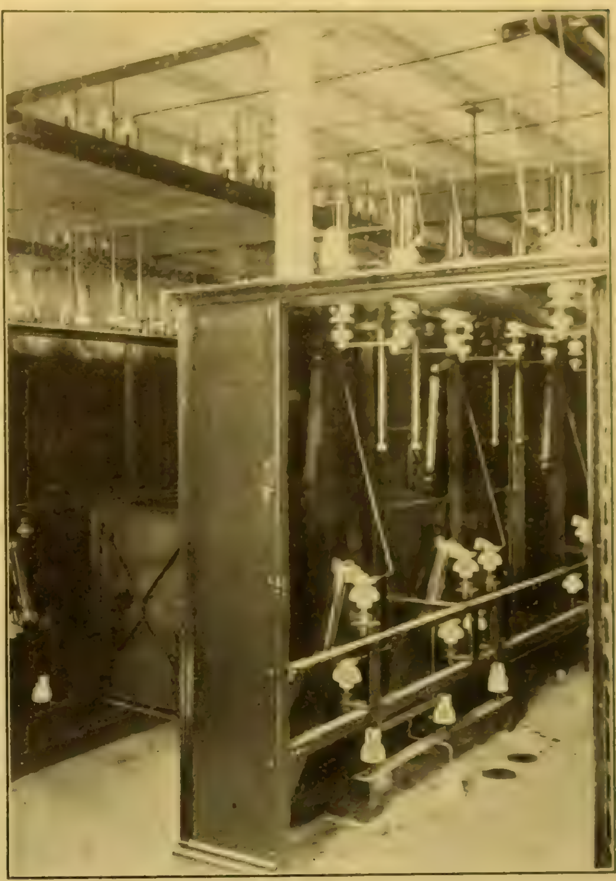
The switchboard is placed on a platform at the end of the building. Underneath this are the high-tension bus bars, to which lead the cables from the alternators. Here also are the safety fuses, the piston-type switches, and the transformers for the measuring apparatus. This is placed on the front of the switchboard, where, thanks to the arrangement of the connections, it is quite away from the high-tension circuits. The circuit breakers placed below the switchboard, and the rheostats behind it, are controlled from the front by rods. The general arrangement is shown by the illustration on page 67. The entire plan and the construction are simple in the extreme, so that the installations appear rather to contrast in some respects with the other stations of the Alta Italia Company.

From each of the Ceres stations a three-wire transmission line leads to the Funghera plant, with which they will be operated in parallel. Then the total power output—about 7,500 horse—is to be transformed there to 24,000 volts by the method already described as in use at Bussoleno, and transmitted to Turin over the already existing line. This consists of six wires, carried on iron poles spaced 75 metres apart. The lines between the Ceres stations and Funghera are supported on wooden poles treated in part with corrosive sublimate and in part with copper sulphate. They were imported from Switzerland and Germany. The poles are not sunk in the ground, but are supported a few centimetres above the surface by iron stands, set in cement.



THE TURBINES AND ALTERNATORS IN THE CERES STATION.

In order to render each station independent of those up-stream from it, by-pass flumes are provided through which the water may be turned when, for any reason, the turbines of a station are not in operation. These flumes have been the subject of special study. It will be readily understood that to carry the water from one head race to the other, with a fall of 100 metres down a steep bluff between, is a matter of some difficulty. The overflow flumes were made square in section, of concrete-steel, covered, and carried across the face of the escarpment; the slope was broken by basins large enough and deep enough to cushion the force and check the speed of the water rushing down the intervening descents.



GENERAL ARRANGEMENT OF THE SWITCHBOARD.

The Funghera Power Station.—This plant is situated in the valley near Lanzo, and utilises 3,000 horse power obtained by drawing water from the Stura a little above Pessinetto. A canal, about 4 kilometres long, open for the greater part, gives an effective head of 63 metres. From the charging basin the water is led to the turbine station through two penstocks, 1.50 metres in diameter and 200 metres long. Here it drives three Riva-Monneret turbines of 1,000 horse power each at 200 revolutions, coupled to Siemens & Halske alternators of 950 kilowatts each at 3,000 volts, and two smaller turbines of 75 horse power each at 660 revolutions for the exciters. Cables from the alternators lead to the switchboard at the end of the station and thence to the "death chamber" above which is the transformer battery for raising the voltage to 12,000, at which it was originally designed to effect the transmission to Turin. This battery consists of twelve single-phase transformers of 300-kilowatts capacity each, star-connected in threes so as to form three-phase groups of 900-kilowatts capacity. To facilitate cooling, a motor-driven ventilating fan is placed at the base of each. This causes a circulation of air between the windings and between these and the core, which is cross-shaped in section, so that between it and the circular coils there are channels through which the air passes freely. The same raising transformers described as in use at Bussoleno will increase the voltage of the transmission to 24,000. The general arrangement of the station is similar to the others. In it also are installed small motors, controlled from the switchboard, for operating the turbine regulators, and an accumulator battery for reserve in the lighting of the station.

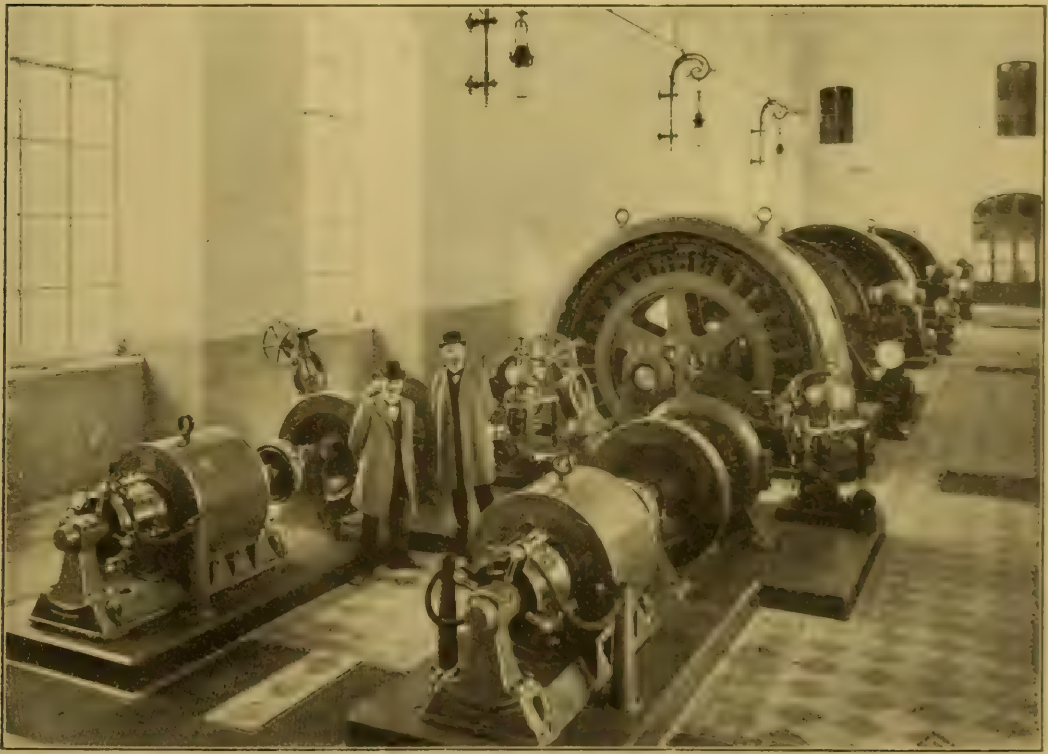
THE FUNGHERA STATION.

To sum up:—the entire enterprise includes the power houses of Bussoleno (1,800 horse power); Funghera, (3,000 horse power); Piansoletti, Chiampernotto, and Rusià (1,500 horse power each)—a total of 9,300 horse power. The main transmissions—Bussoleno-Turin and Funghera-Turin—are to be at 24,000 volts; the branch lines from the Ceres stations to Funghera, at 13,000 volts.

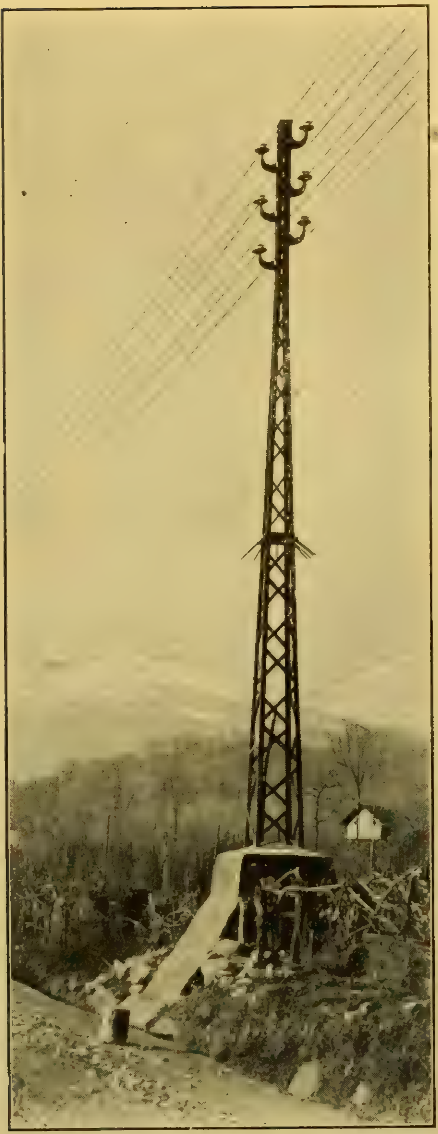
The Ponte dei Preti Power Station.—The Chiusella torrent, descending the valley of the same name (in which is the mining town of Traversella), just before debouching into the plain, makes a long detour around a spur of the mountains and is broken into many rapids and cascades. By means of a dike, 1,450 litres per second are taken from the river and conveyed in a flume, entirely in tunnel, through

THE PONTE DEI PRETI STATION.

the spur around which the stream flows. The flume, 570 metres in length, delivers the water to a charging basin from which it descends by two steel penstocks, 1 metre in diameter and 1.7 metres apart, to the power station. The penstocks are 510 metres long, completely buried in the ground, and at the lower end cross the stream on a concrete-steel bridge to the power plant. This is on the right bank, just below the characteristic "Ponte dei Preti" (Priest's Bridge) on the road from Castellamonte to Ivrea. The effective head is 120 metres.



INTERIOR OF THE FUNGHERA POWER STATION.

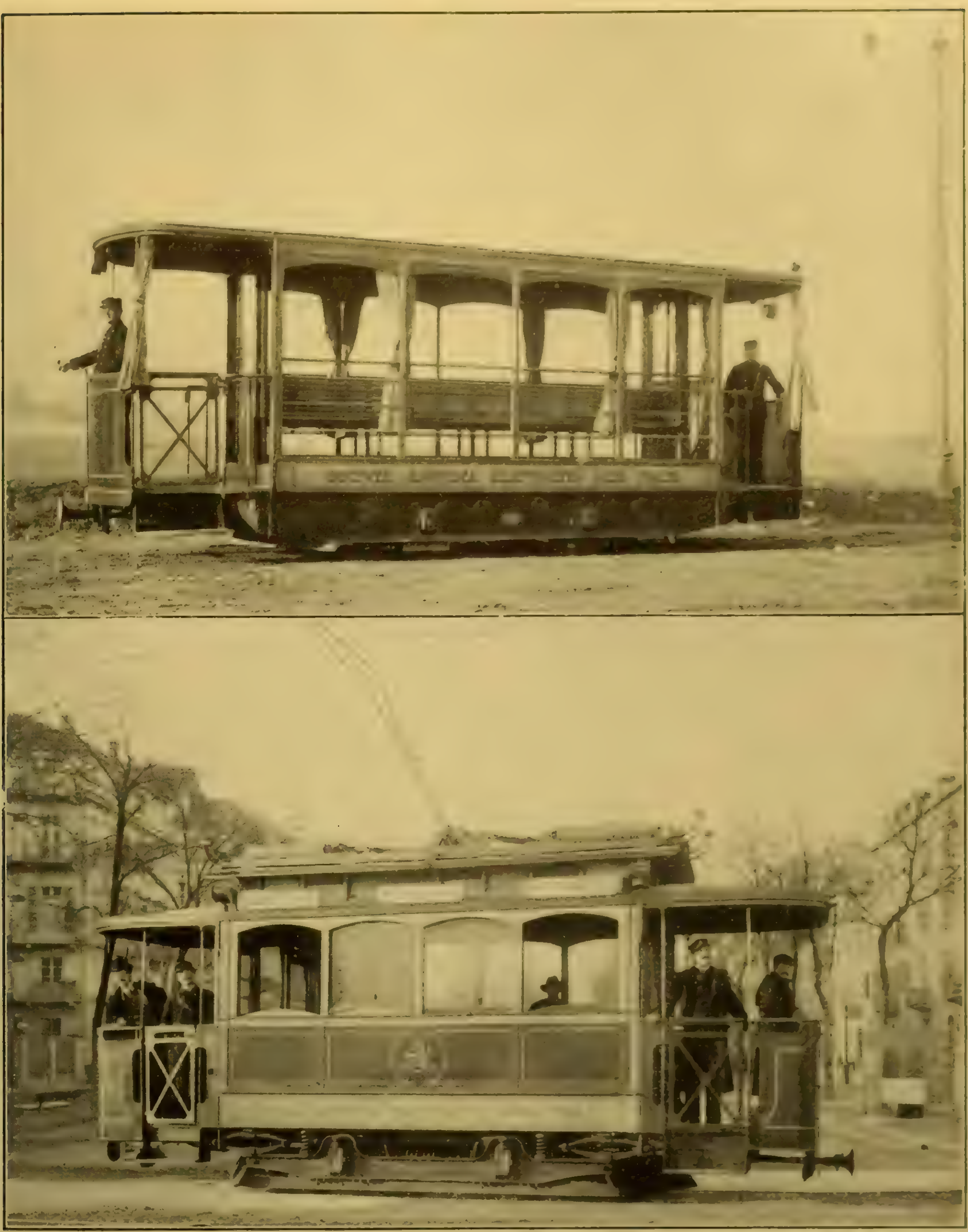


TURIN-LANZO TRANSMISSION LINE.

The station contains five turbines—three of 750 horse power each coupled to 640-kilowatt 440-volt alternators, and two smaller machines for the exciter dynamos. One of the large groups and one of the small sets are reserve. The general disposition is like that at Bussoleno. The 440-volt current goes to the switchboard and then to the transformers. These are seven in number, three-phase, and of a capacity of 200 kilowatts each, with a transforming ratio of 440 : 11,000. As in the other installations, they are placed on a platform behind the switchboard, and below them is the high-tension apparatus.

Small direct-current motors operate the turbine regulators; other direct-current motors drive the oil pump for the servomotors of the turbines, and the air compressor for the maintenance of the air chamber at the foot of the high-pressure penstocks; others still drive machine tools, and move the gates at the head of the penstocks.

Three high-tension lines are carried from the station. One, passing close to Ivrea, goes to Biella, 34.5 kilometres away; a branch leaves this line at Mongrando and carries the current to Sordevolo and Graglia. A second line leads to Strambino. The third divides into three branches, one supplying Valperga and Cuorgnè, another Ozegna and San Giorgia, and the third joining near Caselle the line from Lanzo to Turin. Normally, however, the switch between the lines is not closed, for the tension on the Lanzo-Turin circuit is somewhat higher than that on the Rivarolo-Caselle line. But in winter, when the water is low and the Ponte dei Preti plant is insufficient for the demands made upon it, the Rivarolo-Caselle circuit is cut out and connected with the Lanzo plant, while the Ponte dei Preti power is all used in the Biella circuit, and if necessary supplemented by that from the reserve steam-

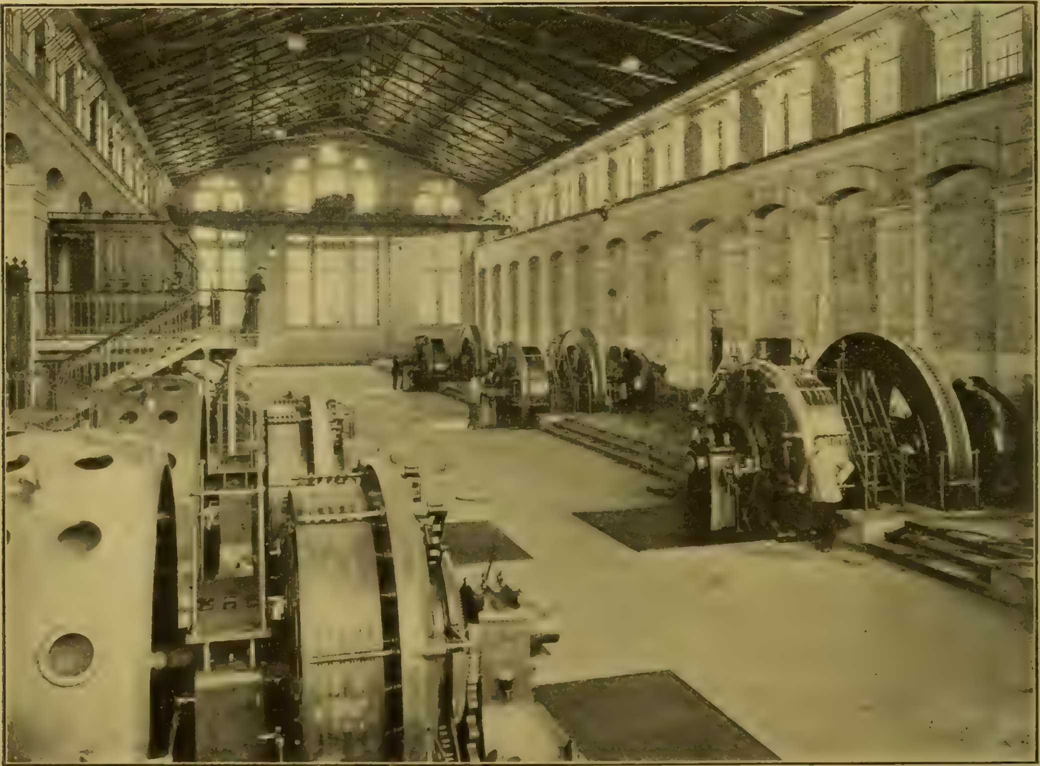


MOTOR CAR AND TRAILER, ALTA ITALIA COMPANY'S TRAMWAY.

power station at Biella. To enable the operation of the Ponte dei Preti and the Lanzo stations in parallel, it is designed to introduce a transformer like those at Bussoleno, so that the tension of the Lanzo current may be reduced a few hundred volts and made the same as that from the Ponte dei Preti installation. The distribution is effected in the form of three-phase current at 120 volts for lighting and for small motors, and at 500 volts for larger motors. At Cuorgnè, San Giorgio, Valperga, and Graglia special Siemens & Halske regulators of the Bussoleno auxiliary-transformer type have been introduced to prevent the variations in tension from interfering with the operation of the lighting service. In these regulators an induced electromotive force in a coil in shunt with the line may be added to or opposed to that of the line itself. Elsewhere the tension of the lighting circuits is regulated by resistances.

All the lines are carried on wooden poles into which are screwed iron pins supporting the insulators. Upon these, especially in front of the transformers, are Siemens & Halske horn lightning arresters.

The Biella Power Station.—At Biella the current from the Ponte dei Preti installation is in part distributed to large motors, provided with their own transformers, in part transformed to 500 volts for a circuit supplying smaller motors, and in part converted into direct current for electric lighting. Altogether, there were recently in use motors aggregating 400 horse power. The conversion into direct current is accomplished in the Santa Marta station. Here two transformers of 150 kilowatts each reduce the tension to 500 volts; the current then passes to two motor-generators, each consisting of a three-phase synchronous motor making 750 revolutions, direct-coupled to a 100-kilowatt four-pole dynamo wound for a tension of 220 volts, which can be pushed up to 300 volts. The variable tension is to facilitate the



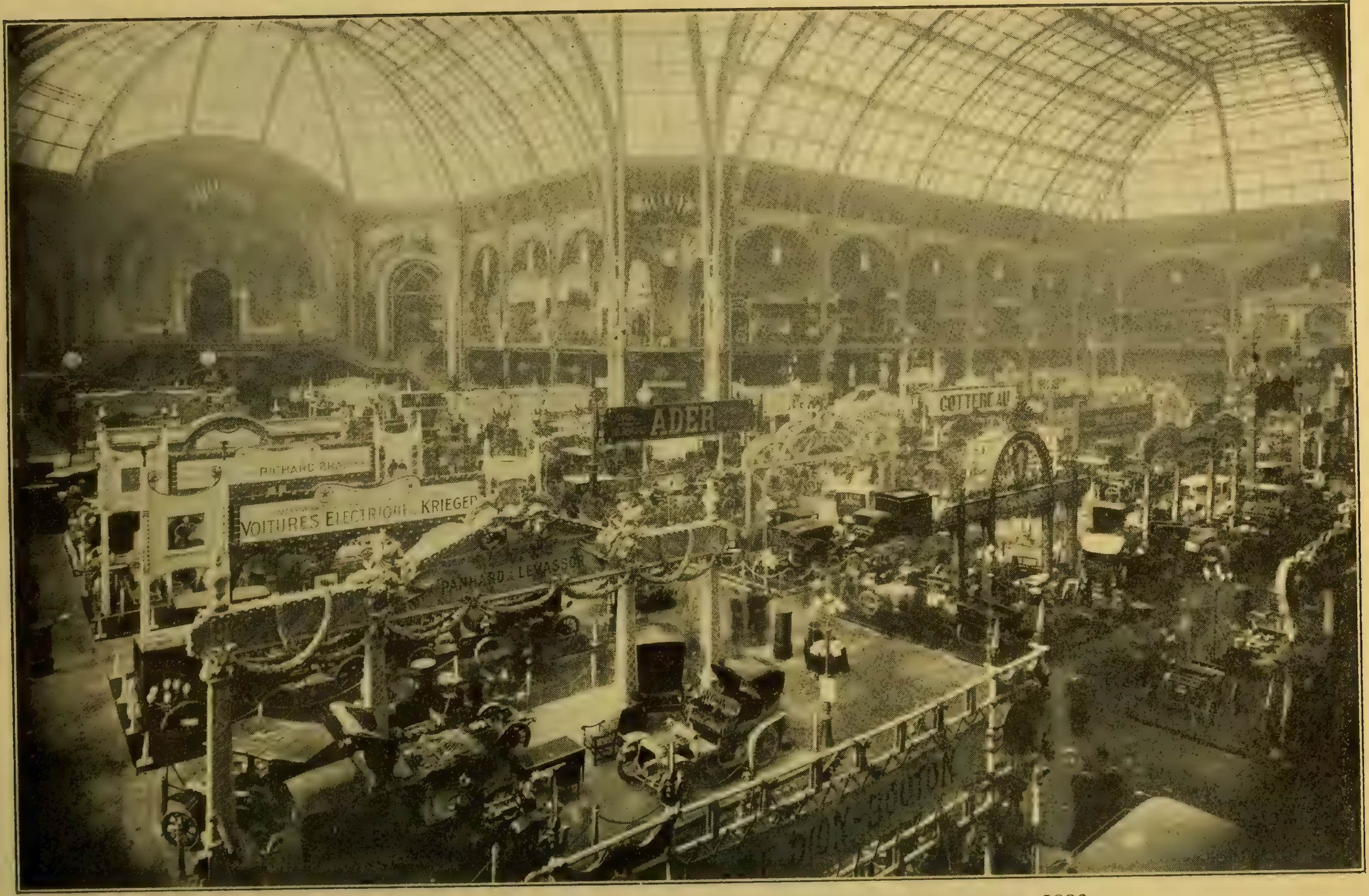
INTERIOR OF THE TURIN GENERATOR STATION.

charging of the accumulator batteries, of which there are two in series, each composed of 130 elements, and of a capacity of 900 ampere-hours for a three-hour discharge. The two direct-current dynamos are connected in series with the terminals of the batteries, and the neutral wire of the distributing network is connected to the central point; the maintenance of a uniform tension of 220 volts on the lighting circuits, with a variable voltage in the charging dynamos, is effected by the insertion of two double transformers. Excepting one feeder line composed of two cables, the entire distributing network is aerial.

As a reserve to the hydraulic installation, and especially to supply any deficiency during the winter period of low water, a steam power plant has been installed upon the banks of the Cevro, a stream, flowing through Biella. It is equipped with a battery of boilers carrying 13 atmospheres, with economisers and superheaters; the engine is a tandem compound by Franco Tosi, of 500 horse power, direct connected to an alternator of about 500 kilowatts at 125 revolutions. The tension is 500-550 volts; it may be raised by three 170-kilowatt three-phase transformers of 9,500 volts, the tension at which the current from Ponte dei Preti reaches Biella. Normally, however, the steam-driven alternators are connected with the 500-volt three-phase circuits from the Santa Marta station, which they thus reinforce. A 23-kilowatt 220-volt exciter is provided in this station; it is so arranged, however, that if desired the alternator may be excited by current from the Santa Marta station.

The Turin Stations.—These are two in number—a transformer and a generator station. Of the former description has already been given. The generating station contains six tubular boilers, and three horizontal steam engines of 900 horse power each, direct-connected to 600-kilowatt dynamos. The other machinery in the station consists of rotary converters, auxiliary sets for charging the accumulators, a storage battery of 300 Pollak cells, and (in the sub-station) another storage battery, auxiliary charging sets, and boosters.

As already stated, the Alta Italia Company furnishes electric power not only to private consumers, for light and power, but also to several lines of tramway of which it is concessionaire. Originally these were operated on the mixed system—that is, trolley in the suburbs and storage battery in the centre of the city; but storage-battery operation was so burdensome to the company that in order to secure consent from the municipality to the general adoption of the trolley, the company paid a considerable gross sum to the corporation and gave it a larger interest in the receipts of further operation.



GENERAL VIEW OF THE INTERNATIONAL AUTOMOBILE EXPOSITION, PARIS, 1903.

THE INTERNATIONAL AUTOMOBILE EXPOSITION AT PARIS.

By Lucien Perissé.

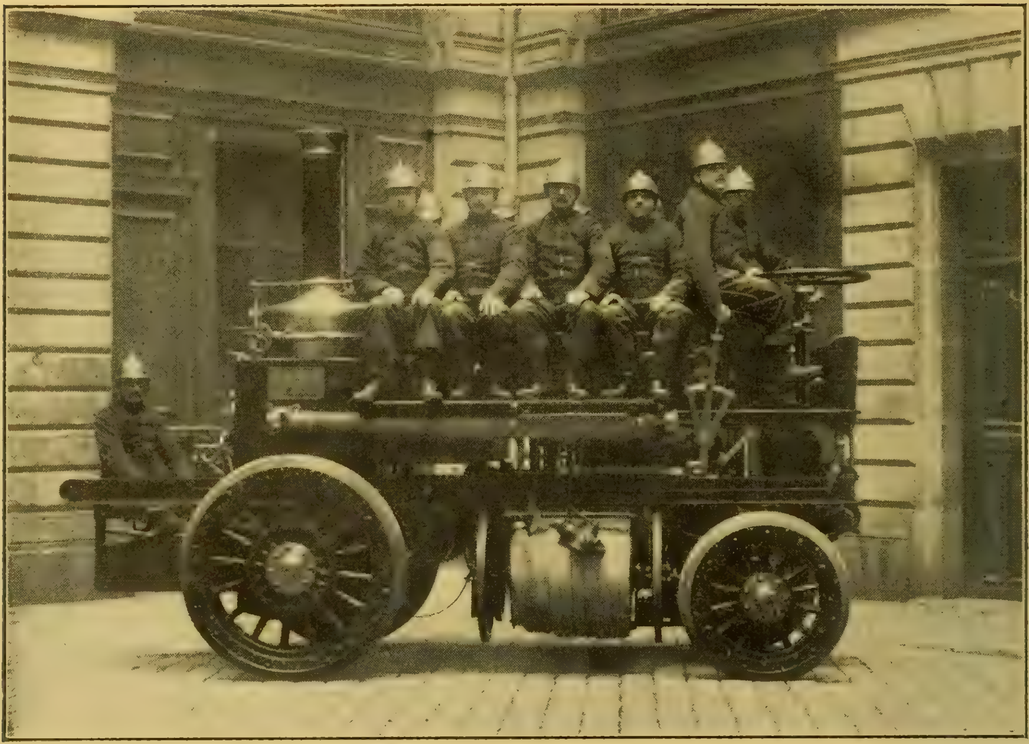
France has taken a notable part in the development of the automobile, and M. Perissé in his technical work has been closely associated with this development. He summarizes in this article the most salient mechanical features of the recent Exhibition in Paris.—THE EDITORS.

THE President of the French Republic inaugurated, on the 10th December last, the sixth exposition organised by the Automobile Club of France at the Grand Palais of the Champs Elysées at Paris.

By its splendor and the number of exhibitors, the success of this exposition far surpassed that of former expositions, and the photograph gives but a faint idea of the wonderful whole.

All the stands of the exhibitors were very well decorated, and almost all were lit up at night by garlands of many colored electric lamps, thus contributing to the success of the fairy spectacle which M. Gustave Rives, the celebrated architect of the Automobile Club of France and general manager of the exposition, put before the visitors. M. Rives pushed his boldness in the art of decoration to the point of bespangling, like a starlit sky, the immense hall of the Grand Palais with from thirty thousand to forty thousand electric lamps shaded in yellow. At the highest point of the central dome, 60 metres high, the arrangement of these lamps along the iron work of the metallic framework formed an immense sun, which, at nightfall, sprang into light with a single touch. The marvellous lighting thus effected allowed the general manager to keep the exposition open until ten o'clock at night, inducing visitors to come from all the extremities of the capital, for the immense Palais seemed to be, during the evening, a gigantic lantern, reddening the sky as if by a tremendous conflagration. The whole of the Avenue Nicholas II and the façade and approaches to the Palais were also illuminated; the organiser installed about 60,000 lamps in the course of a few days.

On the opening day more than forty thousand persons were admitted, not without difficulty, into the exposition, and the crowd of people there about four o'clock in the afternoon was such that it was



AUTOMOBILE FIRE ENGINE OF THE PARIS FIRE DEPARTMENT.

necessary several times to close the doors. These figures are eloquent, and speak for themselves as to the number of partisans and admirers which the automobile industry has in France.

The central part of the Grand Palais was occupied by the carriage builders, the adjacent galleries by the builders of bodies and the wheel and pneumatic-tire makers, while the first story was reserved for the makers of accessories and of wearing apparel for the sport. Lastly, a large space was given up this year to the builders of automobile boats.

The success of the exposition was endorsed by the presence of numerous foreign visitors and also by the interesting exhibits from foreign manufactories of automobile constructions. Side by side with the celebrated German Mercédès, winner of the Gordon-Bennett cup, must be mentioned the Italian automobile works of Turin, the Spyker factories of Amsterdam, several English and Belgian makers, and, as representative of the United States of America, the celebrated Oldsmobile carriages, of a style very original and very different from European carriages.

Several interesting novelties must be singled out:

1. Bulky Machines, called "Heavy Weights." The city of Paris exhibited a new steam fire-engine automobile constructed by the

Société des Etablissements Weyher et Richemond de Pantin (Seine) for the Régiment des Sapeurs-Pompiers de Paris (Paris Fire Department). This powerful engine, shown in the illustration on page 76, was constructed to fight fires of exceptional violence, and also to aid the towns on the outskirts of Paris, which do not usually possess powerful fire engines. It is entirely complete within itself, for it carries with it its staff of eleven men and its equipment, which latter comprises 600 metres of hose and nine hose-nozzles, two bobbin reels, one hook and ladder, and all necessary accessories, without the necessity of being accompanied by an auxiliary wagon. As in the steamers already in use, the water in the boiler is constantly kept at a temperature of 100 degrees centigrade, which allows the requisite pressure for starting to be obtained in three minutes. The normal speed of the automobile being 24 kilomètres an hour, these three minutes are easily recovered, especially when the distance between the station and the place of the fire is of some length.

The pump can discharge 2,000 litres a minute, and the vertical two-cylinder compound steam engine develops 30 horse power. For starting and for the ascent of the steep gradients, the mechanician can, by means of a simple handle, placed under the steering wheel, turn high-pressure steam directly into both cylinders at a pressure of 10 kilogrammes per square centimetre. Under these conditions, the engine develops more than 40 horse power. The same engine does duty for the traction of the automobile and the working of the pump, and when the vehicle is in motion the driver varies the speed of it simply by the touch of the regulating lever placed at his right hand, by means of which he varies the speed of the steam engine. The same lever serves for reversing, and all this is obtained without the interposition of any other appliance for changing the speed. The driver can very easily steer with his left hand, thanks to a very large steering wheel; he has under his foot a progressive brake acting upon the driving wheels. In addition to this, the chauffeur, who rides at the back, has under his hand a brake which acts upon the differential shaft controlling the pinions and chains which drive the wheels.

Electric and petroleum-driven motors have already been applied in numerous ways to the traction of fire apparatus. But this new automobile steam engine is an improvement, for it allows of rapid transportation in the same vehicle of both the men and implements to fight great fires. It does the greatest credit to its constructor and to Lieutenant-Colonel Vuilguin, the officer who designed it.

The Continuous Propulsion Automobile Train consituted an original novelty. Its inventor, Colonel Ch. Renard, who constructed in 1885 the first dirigible electric balloon, "La France," designed this train for the transport of the commissariat of the French army. In this instance he employed a steam locomotive, whereas the train exhibited lately consisted of a series of lighter vehicles intended to be coupled behind a petroleum-driven locomotive of 50 horse power.

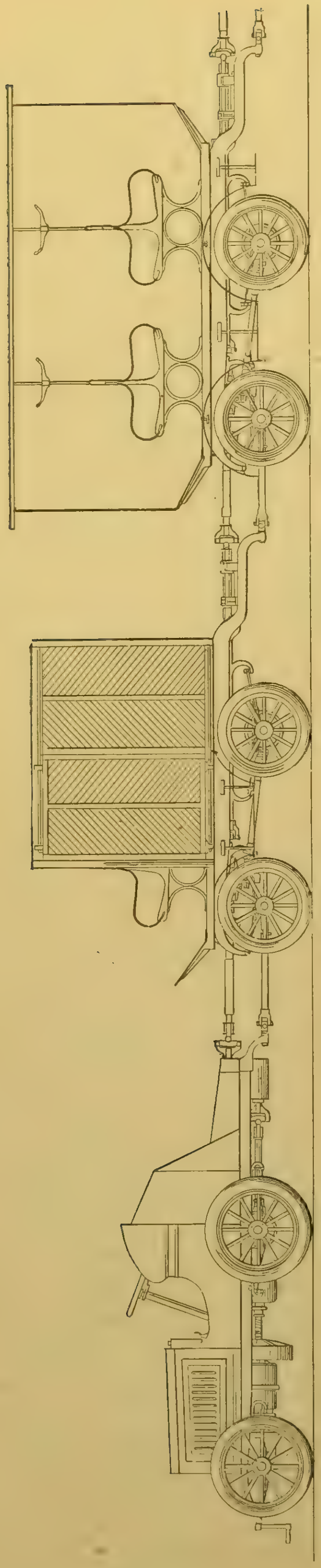


DIAGRAM OF RENARD CONTINUOUS PROPULSION TRAIN.

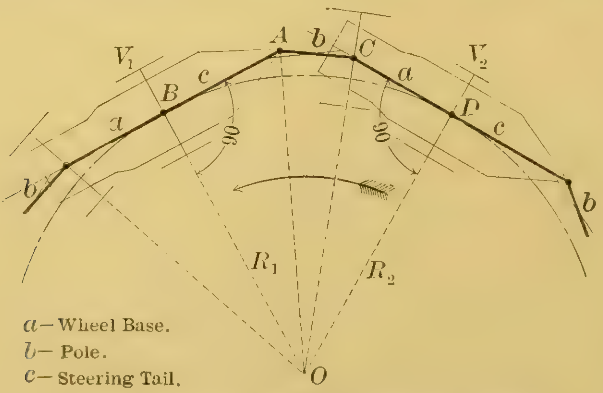
For several years back French and English constructors have sought to solve the problem of the "Heavy Weights"; that is to say, they have tried to transport loads of several tons either upon single vehicles or upon trains. The former have been employed principally in France; such are the steam trucks of de Dion-Bouton, Turgan-Foy, Purrey, etc.; the latter, with steam road locomotives, have been in especial favour in England. This method of mechanical traction was applied during the Transvaal War. If trucks carrying from 4 to 10 tons of merchandise and weighing, dead weight included, 8 to 16 tons, are employed, the difficulties which are met with, owing to these extra weights being distributed only upon two axle trees, are numerous; but the chief is the speedy deterioration of the roads, especially if the use goes on every day over the same route. This inconvenience is very much increased with the employment of road locomotives, which themselves weigh 15 to 20 tons, when they are required to draw a train of several carriages heavily loaded. In practice, the locomotive should possess in itself the adhesion to the ground necessary for the traction of the total weight of the train, and this adherence, calculated and limited for traction on the level, becomes altogether insufficient on gradients or upon a slippery surface. Practically speaking a mechanical tractor can only draw, upon a road not entirely level, a train of which the weight is hardly greater than its own. The greatly augmented weight of the tractors and the considerable strain exercised by the driving wheels at the point of contact with the ground are two material causes of the deterioration of the roads, for this strain is, for two wheels only, equal to the tractive resistance of the whole train.

It is to avoid these manifold inconveniences that Colonel Renard has contrived the train with *continuous propulsion.* In this system there is no single tractor. The carriage placed at the head of the train is provided with a motor, the power of which is distributed to all the other carriages by means of a longitudinal articulated shaft, which, extending from one end of the train to the other, drives one pair of wheels in each of the carriages. Each carriage is thus a motor, the foremost serving only to generate the power for the whole train. Under these conditions, the adhesion to the ground is due to the weight of the entire train; it is proportionate to the resistance to be overcome and each carriage moves itself as if it were isolated. The first carriage, called the "locomotor," is not greatly heavier than the rest, thanks to the lightness of the petroleum motor. Moreover, the effort exerted at the rim of the driving wheels is the same as if each carriage were isolated. Consequently, thanks to the employment of carriages lighter than a tractor and to the distribution of force among all the driving wheels of the train, the deterioration of the roads is much diminished.

The articulated shaft is furnished with universal joints and with sundry arrangements which allow the train to follow the most tortuous track and permit of the coupling and uncoupling of carriages at will.

The continuous-propulsion train presents another advantage over the highway trains previously employed. On account of the tendency of carriages to deviate at the turns of the road, from the track of the tractor or of the preceding carriage, it was very difficult, in practice, to steer a train upon a very winding road or around sharp corners above all on gradients, or when the slope of the road surface was considerable. A train of several carriages could not proceed except upon roads almost straight, almost level, and of which the serviceable width of causeway served to counterbalance, without inconvenience, the curvature. Colonel Renard applied to his train the principle called "accurate turning," by means of a special arrangement of the coupling of the carriages called "steering coupling." The accurate turning causes all the carriages of the train to follow precisely the circle described by the first carriage, whatever may be its radius, and the arrangements devised by Colonel Renard apply as well to the ordinary front running gear of horse vehicles as to the front gear with two pivots employed in automobile vehicles.

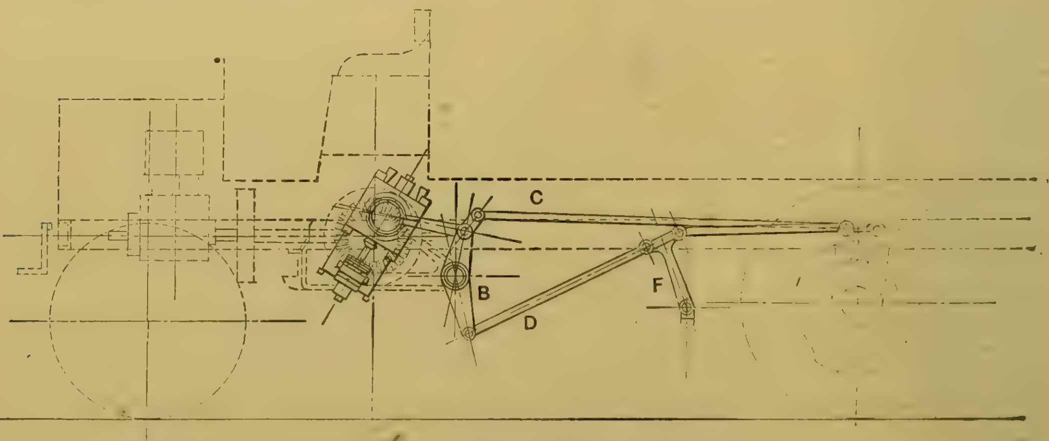
The inventor has succeeded in solving the problem by a geometrical combination of the elements of coupling and steering. These three elements are *l'empattement* (the wheel base), *le longueur du timon* (the length of the carriage pole), and *la queue* (the tail piece).



THE RENARD TRAIN STEERING GEAR.

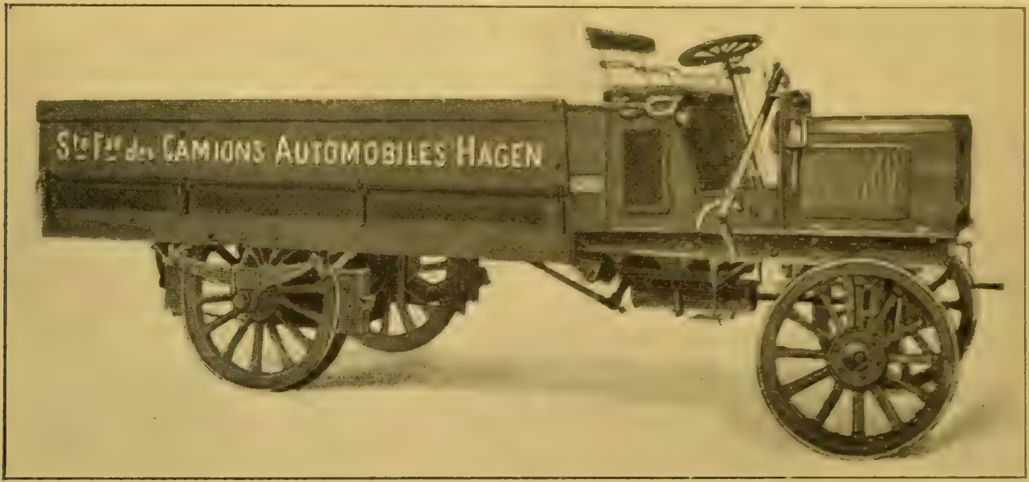
The steering tail *c* at the rear of each car turns the pole *b* of the next car and sets the wheels. Using the Ackermann gear the cars follow each other so accurately that the entire train makes but a single pair of ruts in sand.

The wheel base is the distance which separates the two axles of a carriage; the length of the carriage pole is measured from the front axle to the point of articulation with the preceding carriage; and the tail piece is the distance from the rear axle to the point of articulation with the carriage following. These three lengths being suitably chosen, all the carriages will follow exactly the track of the locomotor in front without deviating more than 30 centimetres under the most unfavourable circumstances.



DRIVING MECHANISM OF THE HAGEN AUTOMOBILE TRUCK.

The driver upon the locomotor drives the train with ease. In fact, his sole concern, as in all single automobiles, is with the steering, changes of speed, and braking. If he steers the locomotor properly, he is sure that the carriages of the train will follow his track with precision. The change-of-speed apparatus is of the ordinary description; and, moreover, a special appliance called *variator* has the effect of reducing in a determined proportion the speed of the train without interfering with the ordinary change-of-speed apparatus. In practice, when the locomotor is isolated, the variator is put in its first position and the change of speed allows the locomotor speeds of 16 to 72 kilometres an hour. If it is followed by 8 to 10 carriages, the variator is fixed for a low speed and this ranges from 4 to 18 kilometres an hour. It is therefore easy to enumerate the many applications of so adjustable an apparatus, for the quick transport of merchandise in any public service or in any industrial enterprise. Finally, the braking upon the longitudinal shaft which transmits the power affects all the vehicles in the same degree, and thus provides a continuous brake.



HAGEN AUTOMOBILE TRUCK, WITH PETROLEUM MOTORS.

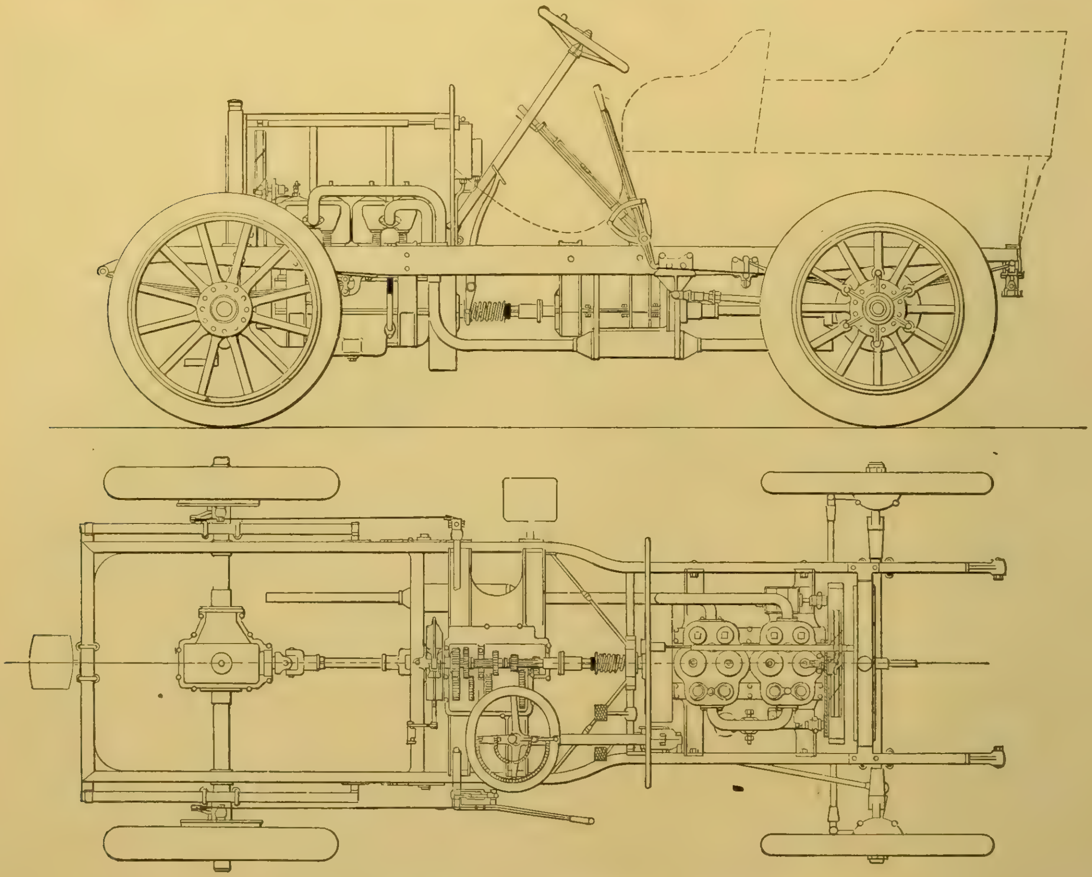
Weight, 3,060 kilogrammes; load, 5,390 kilogrammes; 12 horse power.

The advantages of the automobile road train, Renard system, over the ordinary road train or the heavy-weight load-carrying vehicle, are unquestionable and can be summed up thus:—

Less dead weight and consequently less deterioration of roads; facility of driving the train comparable to that of a single automobile; economy of labor; and wide range adaptation while using a given power, through the ability to vary at will the factors of effort and speed.

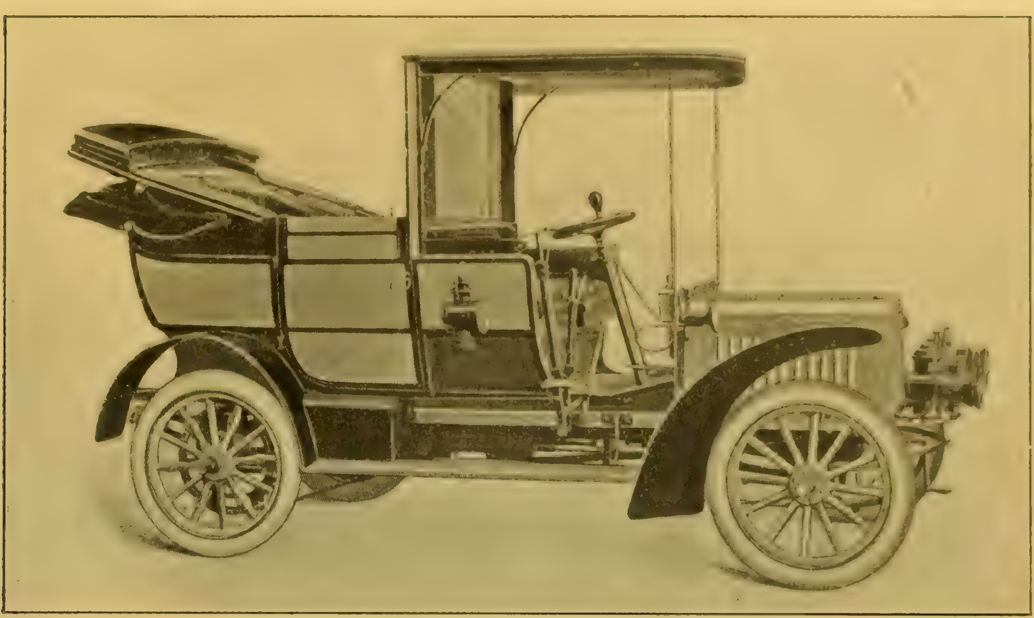
Several constructors exhibited truck automobiles capable of carrying several tons of useful load—for example, the petroleum trucks of MM. Desmarais and Morane and those of MM. de Diétrich et Cie., the steam tractors of MM. Turgan-Foy and Mr. Scotte, already tested in past years, and lastly a petroleum-driven truck of peculiar make, exhibited by the French Hagen Automobile Truck Company (Société Françai̇s des Camions Automobiles Hagen).

In this the power of the motor is transmitted directly by means of a system of two connecting rods with ratchet gear driving the two rear driving-wheels. This arrangement gives a higher efficiency from the motor and thus appreciably diminishes the consumption of fuel. In addition to this, a special patented arrangement makes it possible to increase or diminish progressively the length of stroke of the levers which operate the ratchet in such a way that instead of having only three or four speeds we pass gradually from the zero speed up to the maximum speed of 14 kilometres without check through all the intermediate speeds. It follows that the power exerted by the motor is always exactly proportioned to the work required.



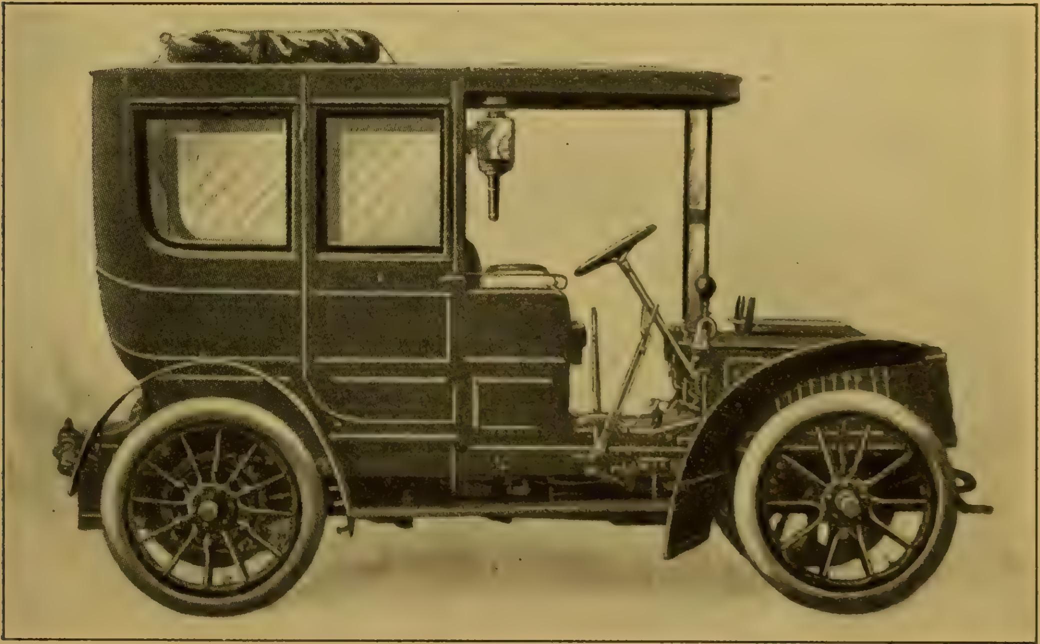
THE HOTCHKISS AUTOMOBILE CARRIAGE.

The rear axle upon which the ratchet is fixed also carries a revers-



LANDAULET, FOUR SPEEDS.

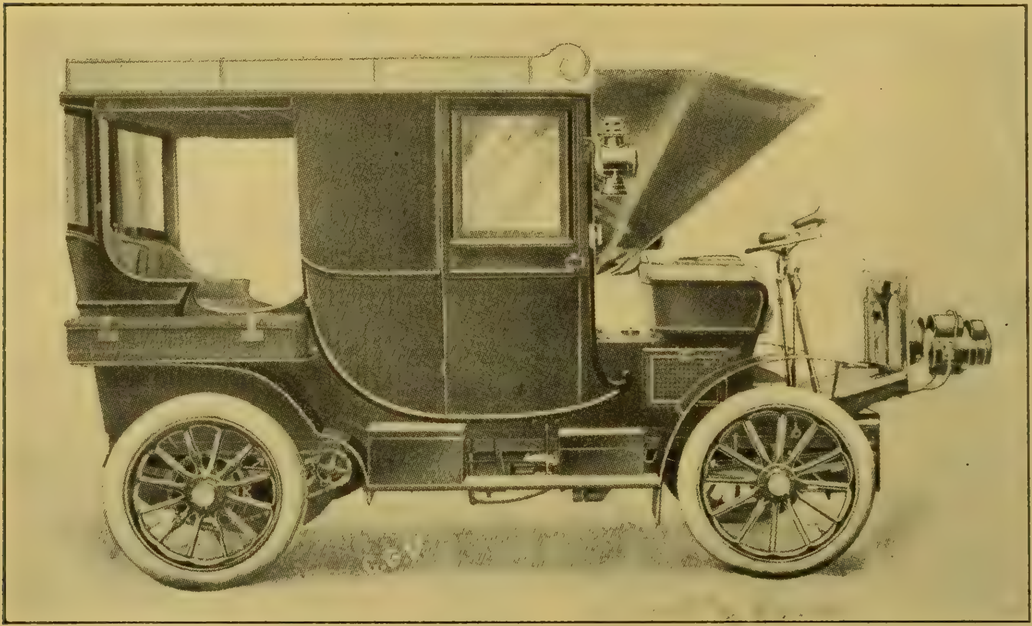
ing gear and a differential by direct gearing, which allows the axle to be made of a single piece—an appreciable advantage in conveyances designed to carry heavy loads. The weight of the Hagen truck when empty is 3,060 kilogrammes; the weight of the useful load, in a recent experiment, was 5,395 kilogrammes, which gave a total weight of 8,455 kilogrammes. In spite of this heavy load, the two-cylinder motors of 12 horse power behaved well, and the economy as determined was satisfactory.



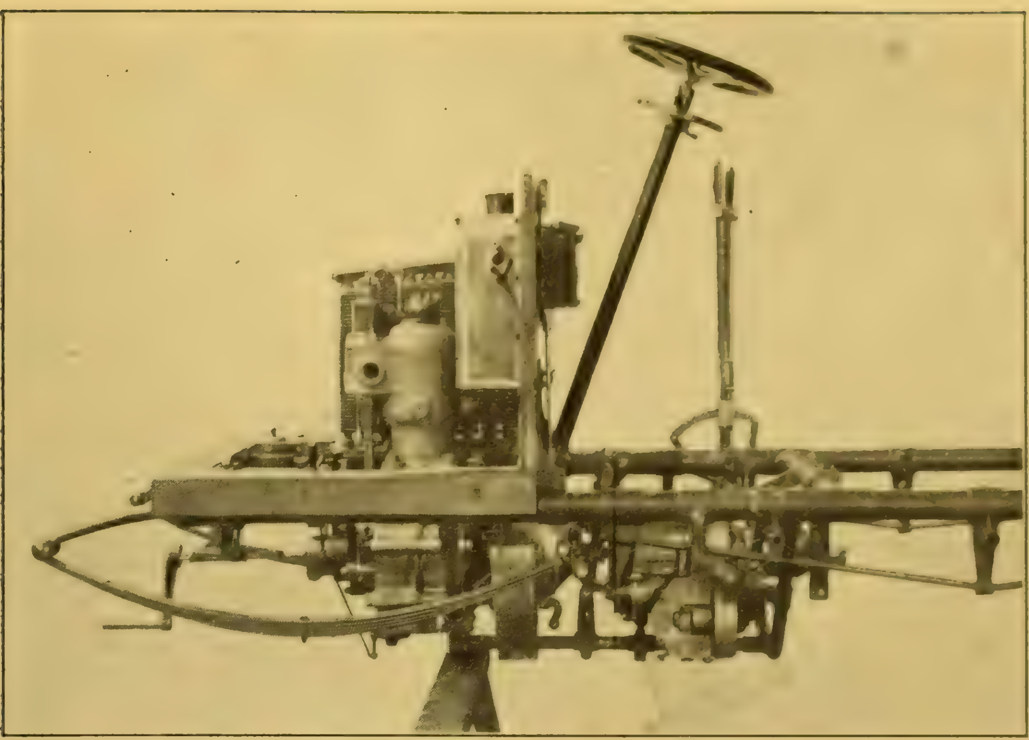
"LIMOUSINE COUPÉ," BY DE DIETRICH & CIE.

2.—Carriages for Town and Touring.—The number of constructors of these carriages, and the number of carriages exhibited, were so considerable that it would require several numbers of this magazine to review them all.

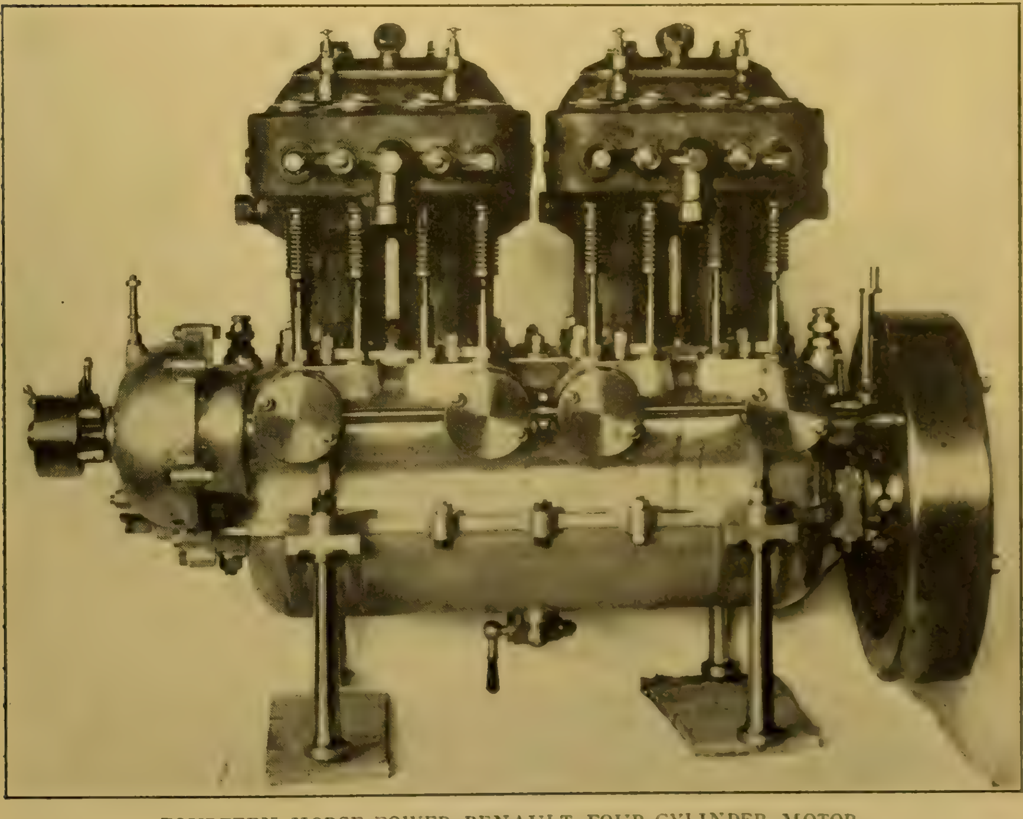
One new automobile builder exhibited for the first time, and the carriages justly drew the attention of visitors. This was the Hotchkiss gun company, Société Française de Canons Hotchkiss, which turning from the manufacture of cannons, has set itself to the construction of the machinery of peace. The construction of these requires as much care as that of artillery, in the choice of materials and in the manufacture, and this firm has put out as its first product an admirable carriage—frame of very light nickel steel, four-cylinder motors, of which the crank shaft (of nickel-chrome steel) turns upon five ball-bearings; valve-motion gearing of vulcanized fibre to deaden the noise; all the speed-changing gear furnished with ball-bearings, and finally a universal joint and a very well designed rear axle, with ball-bearing for both rolling and thrust bearings. MM Spyker Brothers of Amsterdam also exhibited for the first time. Their four-cylinder motor presents a peculiar and original mode of construction. Each cylinder with its valve-chest and water jacket forms a unit, with surfaces so faced and dressed that it may be assembled against the neighbouring cylinder; when all are thus put together the four cylinders and all the valves are cooled by a single water jacket, without any connections by piping. MM Spyker also exhibited a six-cylinder



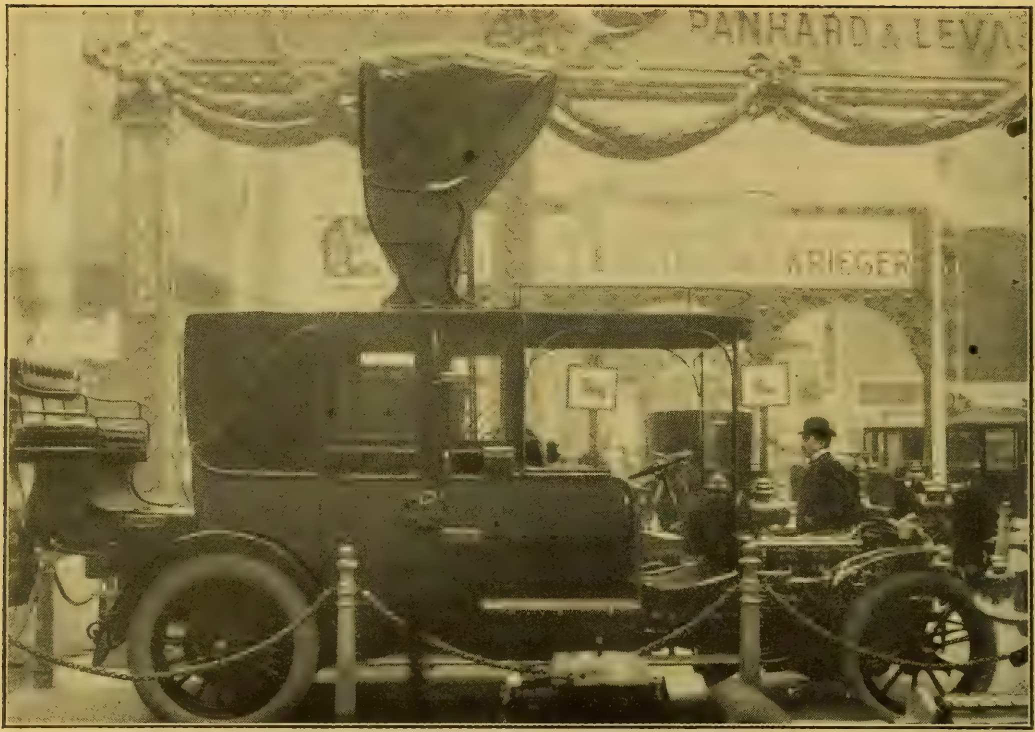
TWENTY-HORSE-POWER BERLINE, CHARRON, GIRARDOT & VOIGT.



RENAULT CHASSIS FOR 7-HORSE-POWER MOTOR CARRIAGE.



FOURTEEN-HORSE-POWER RENAULT FOUR-CYLINDER MOTOR.



TOURING BERLINE, BUILT FOR PRINCE ORLOFF BY PANHARD & LEVASSOR.

carriage of 20 horse power, the power being divided between the rear and the front axle, the latter being at the same time the steering axle.

MM Renault Brothers, Parisian builders, the winners of the Paris-Vienna race, showed carriages remarkable for their simple, light, and well-finished construction, of which the annexed photographs give a very exact idea. One of them shows a four-cylinder motor of 14 horse power with all its valves controlled from the same side of the motor. The second shows the front of a chassis with single-cylinder motor of 7 horse power. It is to be noted that the Renault establishment keeps to steel tubes in the construction of its chassis, with reinforcement beneath to increase the rigidity while preserving great lightness. Among other builders there appears a tendency to employ pressed sheet steel for the chassis.

The celebrated firm of Panhard-Levassor, which has gained so many victories, exhibited once more models of three and four-cylinder motors. The three-cylinder model of 1904 is of about 8 horse power, and designed to be small, light and well-balanced; it is meant for light vehicles and town carriages. The four-cylinder motors for power greater than 8-horse, like the three-cylinder motors, are constructed with the cylinders completely isolated from each other. The Panhard-Levassor company has found very great advantage in this construction. As in previous years, they have made their frames of wood with metal armour, and they are making chassis of considerable length, as is proved by the photograph we give of the great touring berline, seating ten or twelve, which was ordered from them by Prince Orloff. This berline has a wheel base of 3.85 metres, which means that it will not be always easy to make it take the turnings.

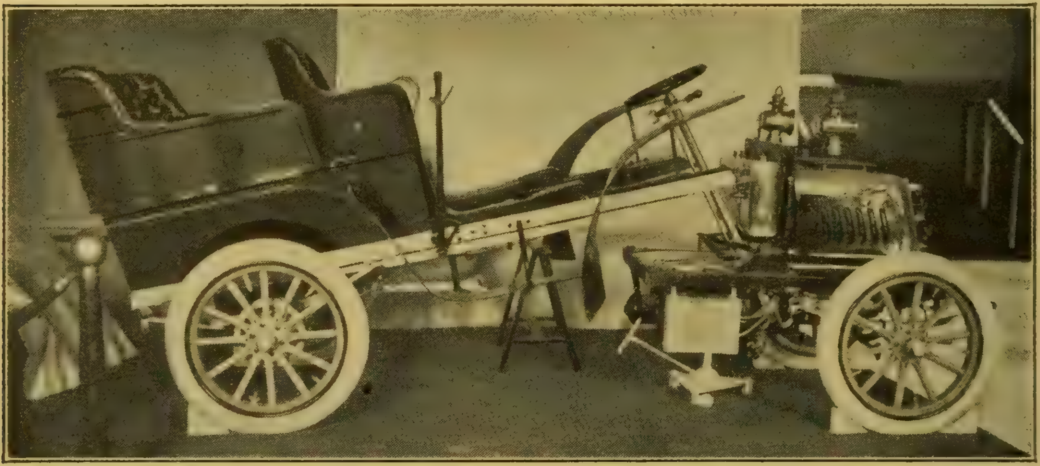
A remarkable feature this year is the general improvement in the construction of carriages, but particularly in the construction of chassis. Statistics of 119 chassis exhibited by French builders (chassis stripped, without bodies), show that the chassis in pressed steel were in the proportion of 46 per cent., those of armoured wood 32 per cent., those of steel tubes 14 per cent., and those in steel sections, 7 per cent. This shows that the pressed steel plate has the most advocates in France. This mode of construction allows of the economical manufacture of very long, rigid, and light chassis. The union of false chassis and of cross-bars can be made by rivets. The engine parts, the springs, and the body are attached by bolts, easy to regulate and unfasten, while the chassis of tubes or armoured wood require either collars, soldered or bolted, or screws or nuts, difficult to unfasten or requiring precautions and very great care in fixing; in short, the mounting of chassis of pressed steel is better mechanics. This construction has been specially studied in France by Mr. Arbel, manager of the Douai iron works, known to all engineers for its admirable construction of wheels and railroad wagons.

Mr. Arbel had a very interesting exhibit of his principal models, among which were pressed plates of a single piece which reflected the

EIGHT-HORSE-POWER DE DION-BOUTON COUPÉ.

greatest credit on the eminent engineer. These chassis have allowed coach builders to construct bodies of large dimensions, assuring a degree of comfort unknown up to the present day, and constituting styles of carriages for town and travel which are guaranteed to render the greatest service during the winter. Formerly automobiling was a summer sport; it ceases to be merely a sport and becomes an institution of every season of the year. The types of large closed carriages called limousine, coupé, laudaulet, berline, etc., can now all be arranged with entrance at the side, and on both sides, precisely like the comfortable horse carriage so long in use in the large European towns. The illustrations on pages 83, 84, give an exact idea of the present constructions of some of the greatest French coach-builders.

The tendency of the public to demand from constructors closed carriages for city use has forced this construction even upon the small chassis of the coupés, and the great manufactory of MM. de Dion-Bouton & Cie. showed a coupé (or landaulet) upon chassis of 8 horse power only, which reflected the greatest credit upon its builders. Thanks to a careful attention to all the details and to a very skilful distribution of the various elements of the body upon the chassis, this coupé is set up with a wheel base of 1.90 metres only.



LACOIN CARRIAGE WITH SEPARABLE CHASSIS.

The Exposition showed also some mixed carriages—that is, carriages having a petroleum motor and one or more dynamos, according to the arrangements adopted. In certain cases electricity produced by a generating unit is utilised by motors which drive the wheels of the vehicle. In this system, electrical transmission takes the place of any mechanical medium for transmitting motion. Such is the mixed carriage of the Parisian Company of Electrical Carriages (Cie. Parisienne des Voitures Electriques) Krieger process. In this carriage a powerful motor is used, as it is not supplemented by accumulators as in the carriages next mentioned.

MM. Mildé & Cie. also employ a generator and motors driving the wheels, combined with a battery of accumulators. The petroleum-essence motor which drives the generating dynamo is of low power.

La Cie. de l'Industrie Electrique et Mécanique (Thury patents) showed a mixed carriage in which a dynamo introduced between the prime mover and the mechanical transmission to the wheels takes the place of a clutch and serves as a speed changer; it is combined with accumulators.

In these two cases the battery of accumulators serves as a regulator according as the effort required is greater or less than the power furnished by the dynamo generator. The battery is charged when running down hill; it furnishes power in an ascent, and aids the prime mover in supplying power to drive the carriage. The advantages afforded by the battery are manifold, but the chief is the possibility of propelling the carriage for a certain distance exclusively with the accumulators, in case of serious damage to the motor *en route*. That might prove to be a valuable assistance.

Two inventors, Mr. Latil and Mr. Albert Colin, exhibited a motor for front running gear, designed to facilitate the mechanical traction of town carriages by the quick and simple substitution of the motor-driven fore-carriage for the fore-carriage with shafts used with horses. This arrangement should find application to public vehicles in large towns and to certain kinds of industrial vehicles.

Mr. Lacoin exhibited an extremely ingenious automobile carriage with detachable chassis. The system consists in mounting a carriage upon two chassis, put together or separated at will in a few minutes. The first is the motor chassis. It comprises the motor, its accessories, speed changes, and the front steering axle. The second, called the "*chassis carrosserie*," supports the body and is mounted upon the rear motor axle.

The two chassis are each of rectangular shape, and the rear one, which is a little wider than the other, is made with prolonged side pieces, like two shafts, on both sides of the motor chassis. At four points of junction of the two chassis a peculiar system of lock-bolting gives rigidity to the whole and prevents all possibility of play. To separate the two chassis all that is required is to unfasten the four lock-bolts and to unfasten the shaft transmitting the motion to the rear axle. For this purpose this shaft is constructed in such a way as to be withdrawn easily by the hand and the shaft of the universal coupling lies alongside of the rear axle, falling into a collar arranged to hold it. The motor chassis of Mr. Lacoin's carriage is so easily removable that it can be yoked at will to body chassis of different lengths and forms. The system promises to render important services, as for example to a private owner who wishes to have several types of different carriage bodies, or to a livery man who is obliged to have winter and summer vehicles, or further, to a business man who wishes to use the motor as he may desire upon a light carriage or upon a vehicle intended for the carriage of merchandise. Although there would be, in the last case, an important difference of weight, the two combinations are possible and practicable, seeing that it is the body-chassis which supports, with the rear axle, the universal coupling, the change-speed gear by bevel pinions, and the differential, all three being proportioned to the weight and the load of the body. This combination of a motor for several vehicles permits of a quicker reimbursement of the cost of the mechanical part of an automobile carriage, which is the most expensive part.

In surveying the galleries it was especially noteworthy that the efforts of the manufacturers were directed towards attaining the ideal pneumatic tire; that is to say, something which cannot burst, which does not come loose, and yet remains flexible. There is not space here to examine the numerous arrangements made to attain the triple end. Let us note only that the tire protectors of leather, provided with iron head plates, are more numerous than formerly. This would appear to be the solution sought for—the direct iron-sheathing of a tire, extolled for the last two years, having the inconvenience of diminishing the elasticity of the tire.

Among the best known brands of tires for carriages should be cited the Continental, the Dunlop, the Gallus, the Falconnet-Pérodeaud and the Michelin. The Exposition of 1903 contained 458 automobile carriages and consequently 1,832 wheels, 1,400 of which were furnished with tires of this celebrated French brand—that is to say, about 77 per cent. These figures show how merited is its reputation.

The Sixth International Exposition of Automobiles is about to close its doors: let us hope that the exhibitors there have secured many orders, and may thus be encouraged to make that of the coming year still more interesting and sumptuous. The strides of automobilism are so rapid that an annual exposition is necessary, were it only to stimulate the ardor of the inventors and builders, as the races do the speeds.

THE COMPARATIVE EFFICIENCY OF INTERNALLY FIRED AND EXTERNALLY FIRED BOILERS.

By D. W. Robb.

It is generally admitted that theoretically the internally-fired boiler should have a lower efficiency than any form which gives better space for combustion, and less close proximity of the fire to the cooling surfaces It is not often that the two types of setting have been accurately and impartially compared, and hence data and results of trials, made by independent authorities upon boilers of nearly the same capacity, with practically the same coal, and under closely similar conditions, demand unbiassed presentation. It must be clearly understood that the following article is not a comparison between two different makes of boilers, but between two different types of furnaces, types which are open to the entire engineering profession for use, both on land and at sea, the whole forming a valuable contribution to practical steam engineering.—THE EDITORS.

PROBABLY most engineers who are interested in steam-boiler construction and economy, have the opinion that a highly heated brick furnace is more favorable to the complete combustion of the volatile hydrocarbons contained in bituminous coal than the cool surface of an internal furnace surrounded by water; but I think it is at least open to discussion whether the more direct utilization of the heat in an internal furnace, by which radiation and air leakage are avoided, does not more than offset the other advantages of the brick furnace. With either arrangement of furnace it is necessary to admit the proper proportion of air, and the air must be heated to a high temperature, say 1400 degrees F., in order to produce combustion of the volatile gases. This air is more easily and more naturally heated by passing through the bed of fuel on the grate than in any other way. If cold air is admitted above the fire, combustion will be checked, even with a brick arch; or if a large amount of coal is thrown upon the fire at once, the air supply will be checked and cooled so that the volatile gases, which are being rapidly set free, will, to a large extent, pass off unconsumed for want of sufficient heated air. Therefore, the question of obtaining perfect combustion with either kind of furnace is largely dependent upon the skill and care of the fireman in having the fire of such thickness that the air supply will be properly regulated and in carefully spreading the fuel in small quantities over the fire.

This result may be obtained mechanically either by the system of underfeed stoking or by down draft on the Hawley plan, by which the volatile gases are forced to pass through the bed of incandescent fuel, thus receiving the heat and air necessary for complete combustion. Either of these systems of stoking may be carried out in a steel furnace surrounded by water as well as in a brick furnace. It is necessary, however, to have the internal furnace large enough to permit complete mingling of the burning gases before they come in actual contact with the cooling surfaces, and in this respect furnaces of small diameter, such as are used in the Scotch or Lancashire types of boilers, are at fault.

In order to make a comparison of the actual economy of the two methods of burning soft coal for steam generation, a table is given, comprising four trials of steam boilers—two of a water-tube boiler, set in brick, fitted with Dutch oven in front, and two of a boiler of the internal-furnace type. These trials were made at technical schools under the direction of careful and experienced men, and the results very fully and exactly recorded; they correspond closely in conditions, the boilers having about the same amount of heating and grate surface, the coal for three of the trials being from the same mine, and for the other trial of nearly the same calorific value.

The trials of the water-tube boiler with Dutch oven (A and C) are taken from a paper by Professor E. A. Hitchcock, of the Ohio State University, presented at the Saratoga meeting, June, 1903, of the American Society of Mechanical Engineers.

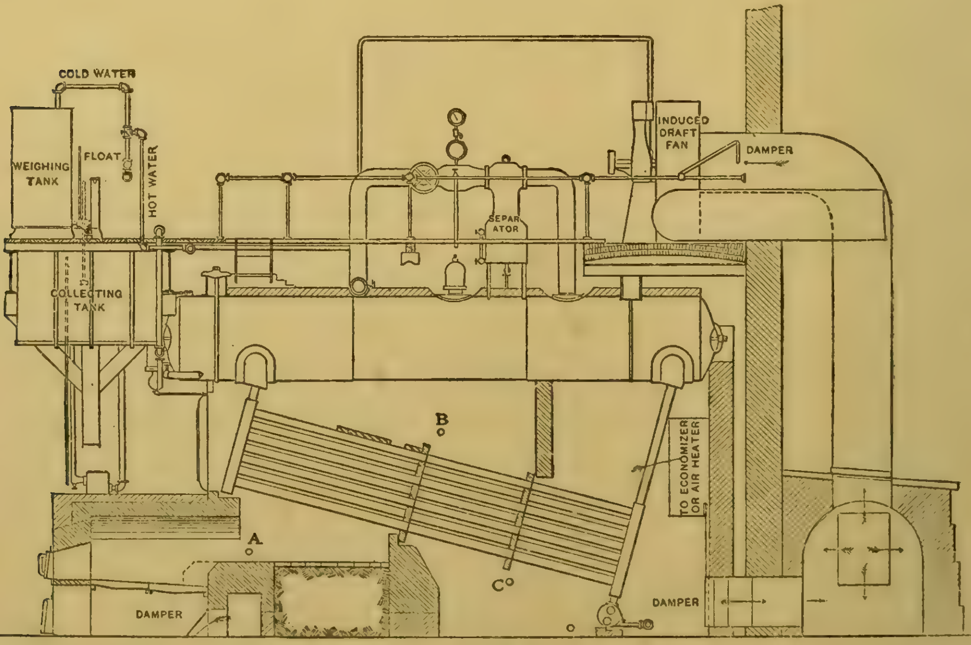


DIAGRAM OF EXTERNALLY FIRED BOILER WITH DUTCH OVEN USED IN PROFESSOR HITCHCOCK'S TESTS.

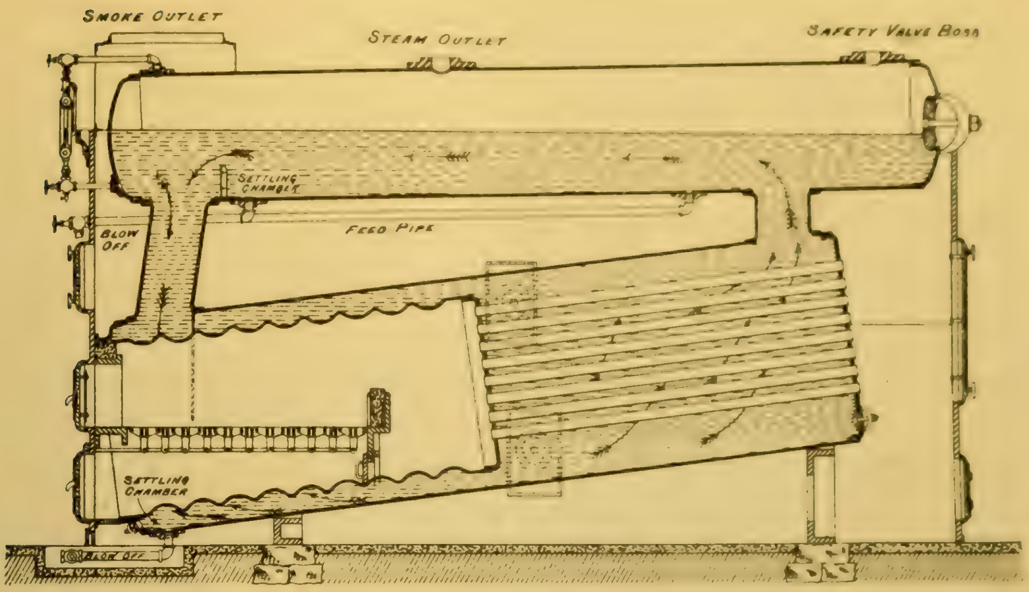


DIAGRAM OF INTERNALLY FIRED BOILER USED IN McGILL UNIVERSITY TESTS.

The trials of the internally fired boiler at McGill University (B and D) are taken from a report by Professor John T. Nicolson, D. Sc., formerly of McGill University, now director of mechanical engineering at the Municipal Technical School, Manchester, England, and Professor R. J. Durley, B. Sc., of McGill University.

Description of Boilers.—The equipment at the Ohio State University, especially constructed for the purpose of boiler and fuel testing, (referred to in trials A and C of the table annexed) consists of a water-tube boiler, a Green's fuel economizer, an air heater, induced and forced-draft fans. The boiler (of the Babcock & Wilcox type) has 56 4-inch by 16-foot tubes, and a 42-inch diameter drum, giving a heating surface of 1,070 square feet. The furnace is of the Dutch-oven or fire-brick-arch type with stationary grates, having an area of 25 square feet. The furnace projects in front, so that the front of the bridge wall is on a line with the front of the boiler, the arch extending 1 foot 6 inches beyond the end of the grate bars. The boiler is arranged so that it may be operated with or without the fuel economizer or the air heater, and with natural draft, induced draft, or forced draft.

The McGill University boiler, (referred to in trials B and D of the table annexed) is of the Robb-Mumford internally fired type, consisting of upper and lower water and steam drums connected by circulating necks. In the lower drum, the axis of which is inclined upwards about 1½ inches per foot of length, is a cylindrical firebox, from which the tubes lead to the rear head of the boiler. On leaving the tubes, the hot gases are passed over the external surfaces of the boiler between the lower and upper drums and inside a steel casing covered with brick. The inclination of the lower shell and a baffle plate around the upper half of the furnace assist in the natural circulation which appears to be unusually brisk. The grate is fitted with rocking bars. The principal dimensions of the boiler are as follows: Lower drum 68 inches diameter by 15 feet 6 inches long; upper steam drum 38 inches diameter by 17 feet 9 inches long; furnace 49 inches diameter by 8 feet 3 inches long; tubes 2¾ inches internal diameter by 7 feet 1 inch long, 148 in number; total heating surface (not including the lower surface of the lower shell which although enclosed is not effective), 1,074 square feet; grate surface 24½ square feet. The boiler is in regular use in the MacDonald Engineering building of McGill University, and is part of the installation which supplies steam for light, power, and heating purposes. It can be worked either under natural draft or with forced draft on the closed-ash-pit system.

Apparatus Employed.—For both sets of trials at the Ohio and McGill Universities, draft gauges were used to measure the draft and thermometers and pyrometers to take the temperature of the air on entering the ash pits and the gases leaving the boilers, also for the feed water. Pressure gauges were used to get the steam pressure, and for the Ohio trials a Barrus calorimeter was used to determine the quality of steam. For the McGill trials the steam was taken as dry. For all trials weighing tanks were used for weighing the water, the weighing tanks opening into a collecting tank below from which the water was pumped to the boilers. All steam and hot-water piping was covered with non-conducting material; all fittings were made tight or blanked off to avoid leakage. The fuel was weighed, the time and weight of each barrow load being noted. Samples were taken with each barrow load for the determination of moisture and for calorimetric tests by a Mahler calorimeter, for the Ohio trials, and by a Donkin calorimeter for the McGill trials.

Methods Employed in Carrying on the Trials.—For the Ohio University trials (A and C) with brick furnace and setting, the boiler was fired continuously from thirty-six to forty-eight hours before the trial, in order that the brick work should be thoroughly heated. About two hours previous to the commencing of the test proper, the fire was drawn, the damper being closed, grate bars and ash pit cleaned, and a new fire immediately kindled with the coal to be used. This new fire was converted as quickly as possible to the condition to be maintained throughout the trial, the draft being regulated to give the desired fuel consumption and depth of fire fixed to secure the best consumption with the least amount of air excess. The tubes were blown free of soot after starting the fire. About ten minutes before starting the test proper, the exact time being noted, the last fresh coal was thrown on, and five minutes later, the fire was levelled with a rake and the thickness determined by resting a bar on the bed of fire and levelling it by sighting on the level gauge and then noting the thickness by graduations on the fire door, which was open just enough to allow the rod to pass into the furnace. At the time for starting, the height of water in the boiler drum was noted on a scale reading in one-tenth inches, fastened to the gauge glass, and a string was also put on the glass at the same point, as a guide for the person controlling the feed water to the boilers. All readings were taken at regular intervals of one-half hour, commencing fifteen minutes after the test started. The firing was done at regular intervals of three to five minutes, depending upon the rate of combustion, and the amount fired was usually two shovelfuls. At the end of the trial, the same methods were employed as regards firing, the thickness of fire, etc., as at the beginning, and if the water in the boiler was not the same height by the scale, the necessary correction was made for this, based on the calibration of the boiler drum. The fire was then allowed to burn out, when all refuse was cleaned from the grates and the pit. The trials were conducted by A. J. Boehme, G. R. Bott, and J. S. Wilson, members of the senior class of mechanical engineering for graduation thesis, carried on under the direction of Professor Hitchcock.

For the McGill University trials, (B and D) at the commencement of a trial the fire was allowed to burn down until only just enough was left to light up a fresh fire, the stop valves being manipulated so as to keep the steam pressure constant. At the time of commencing, a known weight of wood (allowed for as half its weight of coal) was fired and firing then began with weighed coal. The fire was opened up as the production of steam increased. The end of the trial was taken to be the time when evaporation ceased, as the last of the weighed coal died down on the grate. Just enough fire was left to light up again. In this way, any uncertainty as to the depth of the fire at the beginning and end of the trial was avoided. The level in the water gauge was the same at the commencement and end in each trial. The trials formed a portion of the regular instruction course in the department of mechanical engineering at McGill College, and were carried out with the boiler at ordinary work, the remaining boilers in the room being steamed so as to take the fluctuations of the load so far as was possible. In no case was special preparation made for the trial, except that the tubes were swept just before the trial began.

TRIALS OF BOILERS.

(A and C with brick furnace—B and D internal furnace.)

Designation of trial	A	B	C	D
No. of trial (original report)	101 B.E.H.	2	160	3
Date of trial	Feb. 2, '01	Nov. 11, '98	Feb. 12, '02	Nov. 18, '98
Type of boiler	Water-tube	Int'l-furn.	Water-tube	Int'l-furn.
Duration of trial—hours	10	8h. 5m.	9	8h. 22m.
Heating surface—sq. ft.	1,070	1,074	1,070	1,074
Grate " " "	25	24.5	20	24.5
Average Pressures and Temperatures.				
Steam pressure by gauge, lbs. per sq. in.	134	102.5	98	111.5
Steam temperature, deg. Fahr.	358	339.2	337	344.6
Draft at damper, ins. water	.16	.375	.552	.25
Draft in ash pit, " "	+.08	.0	—.02	+.46
Feed water, deg. Fahr.	166	141	53.2	146
Escaping gases, " "	490	427	556	454
Air entering ash pit " "	158.5	39	57.9	70
Air used per lb. coal, lbs.	19.41	17.5	18.6	18.9
Fuel and Water.				
Kind of coal,	George's Creek, R. M.	George's Creek, R. M.	Hackers Run (lump).	George's Creek, R. M.
Coal consumed per hr.—lbs.	375	324.1	581.4	523
Moisture in coal—per cent.	1.08	1.7	.85	2.2
Ash and refuse in coal, per cent.*	8.9	6.6	10.48	6.8
Coal per sq. ft. grate per hour	14.8	13.23	29.07	21.35
Water evaporated per hour, lbs.	3,262	2,832	4,011	4,234
Factor of evaporation	1.094	1.115	1.203	1.112
Evaporation per hour from and at 212°	3,569	3,157	4,826	4,708
Evaporation per lb. coal, lbs.	8.69	8.75	6.889	8.09
Equivalent evaporation from and at 212° per lb. of coal—lbs.	9.518	9.75	8.30	9.00
Heat Value of Coal and Efficiency of Boiler and Furnace.				
A—Heat used in evaporation, B.T.U.	9,192	9,580	8,016	8,480
B—Calorific value of coal, "	14,240	13,900	13,647	13,900
C—Efficiency boiler and furnace, A ÷ B = C = per cent.	64.54	69	58.74	61

Ash and Refuse in Coal.

* The percentage of ash and refuse for trials B and D would have been higher if they had been taken from the analysis as they were for trials A and C instead of by weight. (See Prof. Hitchcock's paper, sec. 20), and for this reason the evaporation per pound of combustible is omitted.

Comparison of Trials.—Trials A of the external brick-furnace boiler and B of the internal-furnace boiler were made under natural or low-pressure draft, and trials C and D of the same boilers under forced draft. All of the trials show the evaporation per pound of coal to be in favor of the internal-furnace boiler, and the total efficiency of the two types of boilers and furnaces based on the heat value of the coal, which forms the true test, shows 4.5 per cent in favor of the internal-furnace boiler for natural draft, and 2.25 per cent for forced draft. It will be noted, however, that the brick-set boiler and furnace was given the following advantages in the trials:—In trial A for the brick furnace with natural draft the air entering the ash pit was preheated to 158.5 degrees F., as compared with cold air at 39 degrees for the internal-furnace boiler, trial B. Professor Hitchcock's trials (Numbers 116 and 117) show that preheating the air to about the same extent gives a direct advantage of 2.4 per cent and an indirect advantage, as indicated by less CO in the escaping gases, of 1.3 per cent. So, it would appear that if the air had been preheated for trial B of the internal-furnace boiler it would have shown a total efficiency of 8.2 per cent better than the brick-set boiler and external furnace.

In the forced-draft trials (C and D) the grate surface was reduced to 20 square feet for the brick furnace and not for the internal furnace. Professor Hitchcock's paper (Sec. 26) shows that the reduced grate surface would give an advantage to the brick furnace through less excess of air.

Loss of Heat of Brick Work When Running Intermittently.—In the trials of the brick-set boilers with external furnace at the Ohio University it will be noted that the boiler was fired continuously from 36 to 48 hours before the trials, in order that the brick work should be thoroughly heated, and Prof. Hitchcock states in his paper (Sec. 20) that as a result of a series of trials made especially to determine that point, cold brick walls continued to absorb heat for 72 hours, and increased the loss during the trial 8.5 per cent., and he also states that brick-set boilers should be preheated not less than 30 hours before the commencement of a trial in order to give their best results. This shows clearly the advantage of an internally-fired boiler in cases where steam is used only during the day time or at intermittent periods, because the internal furnace will give as good efficiency during the first hour of steaming as at any subsequent period. The exact amount of loss in running a brick-set boiler during the day time only is not shown by these trials, but from Professor Hitchcock's results I think it fair to assume it would not be less than 4 to 6 per cent. in favor of the internal furnace.

It will be noticed in comparing the methods of starting and stopping that Professor Hitchcock used the running start, whereas in the McGill trials, the fire was burned down to the lowest possible point before starting and also at the end of the trial. While these methods probably give about the same results, Professor Hitchcock's method would be in favor of the boiler, because the condition of his fire would be at its best from start to finish. It would also seem probable that a fire built up even two hours before the start, as was done in the Ohio University trials, might contain a greater amount of combustible matter at the beginning of the trial than at the end, when there would reasonably be a larger accumulation of clinker and incombustible material on the grate.

The McGill trials do not show any allowance for moisture in the steam; if we assume that the steam from the boiler contained the same amount of moisture as from the brick-set boiler, we should have to deduct 0.8 per cent for trial A and 1.7 per cent for trial C from the results of the internal-furnace boiler trials.

To sum up the comparison:— The comparative efficiency of the two types of boilers and furnaces as shown by the trials with the additions for preheated air in trial A, deducting the moisture in the steam, is 7.4 per cent in favor of the internally-fired boiler when the brick setting and furnace is preheated or run continuously; or if run in day time only, say 11 to 13 per cent. in favor of the internal furnace. Under forced draft and continuous running, the difference shown is slightly in favor of the internal-furnace boiler, although perhaps not outside the limit of error of testing; but under intermittent running the difference would be considerably in its favor.

It may be said that the differences shown by these trials in favor of the internally-fired boiler are within the limits of error of boiler trials conducted by different operators; but taking into account that the firing of the Ohio boiler was done by skilled men, and conducted with a view to getting the best results for the apparatus, while the McGill trials, although carefully conducted, were made with the regular fireman to show the students the methods of testing and the results under ordinary conditions of running;and considering further that the method of starting and stopping the trials at the Ohio University was rather more favorable to the boiler than at McGill—I think the comparison a safe one. But even if the internal-furnace boiler did not give any better results than the brick furnace and setting, it would show that the expense in first cost and repairs of a Dutch oven and brick setting are unnecessary; and especially considering the rapid deterioration and increase of air leakage incident to brick work, when subjected to the intense heat of combustion, they are objectionable as compared with the internally-fired self-contained boiler, which should hold its maximum efficiency in continued service and require much less repairs than the brick furnace and setting.

EDITORIAL COMMENT

WITH the definite settlement of the preliminary questions relating to the union engineering building in New York, so munificently endowed by Mr. Carnegie, attention may now be directed toward the execution of the work of design and construction in a manner which shall render the structure most efficient for its purpose.

While there is no doubt that the best architectural skill will be employed in the design of the building as a whole, it must be remembered that there are numerous features in connection with which the architects may wisely consider the peculiar conditions involved.

We have already illustrated and described in our issue of January last some of the most important houses which have been built in England, France, and Germany for similar purposes, and these examples contain numerous useful hints in this connection.

* * *

IN the first place the meeting hall should be designed with the fact always in view that it is to be mainly a place for the holding of general discussions from the floor rather than for the hearing of addresses from the platform. Nearly all large halls are built for the purpose of enabling an audience to hear what is said upon the platform. In the engineering societies the members who speak from their places in the hall should be heard as readily as the presiding officer, and a hall which is deficient in this respect will exert a most deterrent effect upon active discussion, something which would be most unfortunate. Probably the best examples of successful halls may be found in the rooms of legislative assemblies, such as the House of Representatives in Washington, or the Chamber of Deputies in Paris. The latter room is especially provided with a sort of lower rostrum, just beneath the elevated platform of the presiding officer and above the tables for the reporters, this being for the use of any member who is to address the Chamber. Probably something between the halls of Congress and a medical clinic hall would best serve the purposes of the meetings of the engineers.

Again, at all meetings of the societies there are those who wish to spend but a portion of the time in the main hall, preferring to mingle in conversation with their friends without. This should be made possible by providing a convenient and commodious conversation room, somewhat in the nature of a lobby, to which such ready access should be had as to enable members to leave the main hall and return without materially disturbing the meeting. Such a lobby is not to be confounded with the entrance lobby, where the arrival and departure of members would interfere with the purpose. Rather should it be behind the presiding platform, following again the arrangement in the Capitol at Washington, the access being provided by entirely different doors from those for the service of the arriving and departing members. Furthermore, the main hall should be provided with visitors' galleries, thus enabling the floor to be reserved for members, permitting executive sessions to be held without unnecessary disturbance in clearing the room.

* * *

An important use of the building will be for the holding of receptions, *conversazioni*, and similar entertainments, and it is especially a lesson of experience with existing structures that these involve special arrangements. Extensive cloak rooms for ladies and for gentlemen are necessary, and these should be readily accessible directly from the entrance, and yet so arranged as to avoid the formation of conflicting currents of arriving and departing guests, between the principal entrance and the main hall.

While the libraries will naturally be provided for in a quiet part of the building, there should be some convenient form of mechanical conveyor between the librarian's desk and the various meeting halls, together with telephone communication, so that books needed in the course of discussion may be produced with that promptness which alone can render them available.

These are but a few of the special requirements which may be readily provided if considered in advance of construction, but which would be found difficult and costly of attainment afterwards. A building for engineers should exhibit in every detail the latest evidences of engineering skill and judgment in construction and adaptation for its uses, and with all branches of the profession represented in its occupants there should be no difficulty in obtaining the best expert advice for every detail of the work.

* * *

We have discussed repeatedly in our review columns the advantages of alcohol as a fuel for internal-combustion motors, and the paper of M. Henri Dupays in our issue for February last showed the extent to which the industrial applications of alcohol have grown in Europe. It is now proposed to permit alcohol which has been rendered unfit for drinking purposes to be relieved from the tax of $2.08 per gallon, and a bill to this end has been introduced into the house of Representatives by Mr. Boutell. The bill provides that alcohol, denaturized, to use the European term, by the addition of sulphuric ether, wood alcohol, methylic alcohol, naphtha, or other substances approved by the Commissioner of Internal Revenue and the Secretary of the Treasury, may be removed from distillery warehouses free of tax, the only requirement being the affixing of a ten-cent stamp, indicating its character. The act further provides penalties for the prevention of the redistilling of such denaturized alcohol, and for the storing of the material on the premises of any liquor dealer.

Such legislation is surely needed, and we hope that the bill will become law and that the United States may benefit by the encouragement of the manufacture of alcohol as a fuel for various purposes. It is a far safer and better fuel for automobiles than gasoline, and its production will enable recovery of much value from wastes of such industries as beet-sugar manufacture and the like.

Numerous forms of alcohol lamps have been devised in France and Germany, the flame from a properly constructed lamp rendering an incandescent mantle brilliantly luminous, and thus furnishing a safe and satisfactory substitute for gas and petroleum.

With slight modifications nearly every form of internal-combustion motor can use alcohol as fuel with high efficiency, and the only thing which is necessary to create an extended and desirable industry is the passage and sincere enforcement of the bill proposed by Mr. Boutell.

REVIEW OF THE ENGINEERING PRESS.

"THE WORLD IS ITS FIELD"

MODERN FIREPROOF STRUCTURES.

RESISTANCE OF PROTECTED STEEL-FRAME BUILDINGS UNDER THE TEST OF THE GREAT FIRE AT BALTIMORE.

Iron Age.

THERE are a number of departments of engineering in which it is practically impossible for the completed product to be subjected to any test which shall determine beyond doubt the success which has been attained in the design and execution of the work. Thus a battleship may be prepared from the latest information available, and built from the best materials to be had, and may spend its entire life in cruising and in port, without ever having its real fighting value known. In like manner many so-called fireproof buildings are constructed and remain intact until superseded by some later structure, never having been exposed to any test by fire worthy of the name. For this reason every naval combat is eagerly studied by engineers and officers in order to learn how the different vessels really behave in action, and every great fire gives practical lessons in the art of fireproof construction.

In a recent issue of the *Iron Age* is given a fully illustrated review of the results of the great fire which occurred in the business district of the city of Baltimore, giving probably one of the most valuable reports upon the manner in which the modern steel-frame building, when properly protected, resists fire, which has yet been made.

The first reports, appearing immediately after the fire, contained much erroneous information about the manner in which the steel structures had resisted the fire, but when actual investigations became possible it was found that the tall buildings had not only stood the fire, but that they had, in some instances, served to protect to a partial extent the structures near them. When the Abbé Sieyès was asked what he had done during the French Revolution, he replied, "I survived!" and that answer alone spoke volumes. In like manner the protected steel-frame building survived the Baltimore fire, thus assuring engineers of the correctness of the ideas and methods which have been accepted as standard.

It must be remembered that such buildings, as at present constructed, are not intended to be proof against everything, and the principal idea has been to render them proof against injury from fire having its origin within.

"No effort has been made to guard against the attack from without to which the buildings were subjected. They were all filled with inflammable materials, had wooden window frames on the outside and wooden sash frames and doors within, and in the large majority of cases had wooden flooring laid over the concrete floors. Even though the windows on one or two sides of a building were protected by fire shutters, which was not generally the case, fire attacking the unprotected windows entered the building, raking it from floor to floor, and in many cases destroying the fire shutters, so that they hung in ribbons or fell from the building entirely. The spread of the fire was so rapid that ofttimes one of the tall buildings would stand directly in the midst of furious flames coming from all manner of 'tinder boxes' loaded with highly inflammable materials, the flames licking up the four sides of their tall conductor and uniting over the top of the building, to be tossed on by the high wind against the next tall structure standing in their path. Under such conditions it is no wonder that the mullions between windows were warped and twisted when of steel, fused when of cast iron and cracked and crumbled when principally of stone or terra cotta. The condition of the upper floors of all the tall buildings shows that the heat was much more intense higher up than nearer the street level. This, of course, is quite natural, and, together with the eddies and currents of air created by the terrific suction, which must have been induced by the intense heat high above the pavement, is given by many as the explanation of the excellent condition in which some of the low fireproof bank buildings remained throughout the ordeal and also for much of the freakishness of the fire's course in leaving some things untouched and completely consuming others around the edge of its path.

"The experts who have made careful study of the catastrophe are united on one point, which stands out very prominently—that is, that the fireproofing of the steel members in the tall structures was good, but that what was needed to further protect the buildings was a system of outside fire protection or some means of keeping the flames outside. As to methods of attaining this end opinions differ, and while many believe that wired glass should be used in connection with protected metal window frames, others say that steel shutters would suffice if they covered all window openings. Still others hold to an outside sprinkler system, coming from various floors and forming a sheet of water around a building."

Although the general results of the Baltimore fire were such as to confirm the correctness of the principles upon which modern fireproofing are conducted, certain modifications in details were shown to be advisable. Thus there is danger in the use of very light steel framing, and thorough fireproofing involves a greater weight and stiffness than is demanded by the mere requirements for the loads to be carried. This is especially the case in connection with floor construction and wind bracing.

"It was the opinion that in many cases these were given too wide a span, and the beams were too light to safely hold the proper weight of arch. It has been suggested that these arches should not be of more than 5 feet 6 inches span, and should not be built of less than 9-inch tiling on 12-inch beams. They should also be provided with two tie rods each. The general practice in Baltimore has been to place about 1 inch of terra cotta covering around the lower flange of the floor beams. It has been suggested that this should be just doubled, as in very many cases the inch covering has cracked and fallen to the floor. Plaster composition partitions were proven of no value in resisting the fire, as wherever they were used they were completely destroyed. The consensus of opinion at Baltimore regarding the protection of steel columns was that at least 3 inches of terra cotta covering should be afforded, and that special covering should be provided for covering the piping, outside of the covering around the column.

"Another point shown is that the lightening of the terra cotta tile is a serious mistake, as with their thin webs, as now made, they do not withstand the heat as they should, and as a result the lower web cracks and falls to the floor below during the process of expansion and contraction during and after the fire. It was found that in terra cotta partitions and coverings to columns the tile of 8 inches in width or less held together better than those of more liberal outside dimensions. It was also found that the placing of a piece of wire cloth or similar substance in the joints, thus holding the cement from crumbling, would assist in holding the tile together."

So far as the exterior of the buildings is concerned, the fire showed that stone suffered the greatest damage, while ornamental terra cotta also broke away under the heat. The plainer designs of terra cotta, and the ordinary brickwork stood the heat best of all, and it was fairly well demonstrated that plain brick façades outside of protected steel skeletons, without other ornamentation, would have survived the fire uninjured.

The injury to buildings by the entrance

of fire from without has already been observed upon other occasions, notably in the case of the fire in the Home Life Insurance Company's building in New York, in 1898, fully discussed by Mr. Parsons in our issue of February, 1899; and the damage which may result from the entrance of fire through imperfectly protected windows is well known. This action was emphasised in the Baltimore fire. Commenting upon the subject in the *Iron Age,* Mr. Harry D. Gue, a specialist in insurance engineering, said:

"The most obvious lesson to be drawn from the conflagration in Baltimore concerns itself with the fatal weakness presented by window openings in the outside walls of buildings, unprotected against the attack of fire from without. Buildings having brick or stone walls, when erected in accordance with the laws of any city in America, are of sufficient strength to withstand the attack of ordinary neighboring fires, provided the outside window and door openings are made as fire resistant as the walls they pierce.

"Such protection is thoroughly practical and may be accomplished by either of two means; by iron shutters, or by wire glass windows in metal frames. Both types of protection are approved by fire underwriters, although wire glass windows are preferred by many on account of their obvious advantages. They do not require to be closed in a moment of emergency, being an integral part of the building; they are not subject to corrosion, they are eminently sightly, and when made of polished plate are suitable for use in building fronts where iron shutters are quite inadmissible. And above all, they offer a degree of fire resistance equal to the wall in which they are set."

The experience of Baltimore, then, is positive as to the possibility of constructing fireproof, or more correctly, fire retardent, buildings along the lines which have already been adopted. Plenty of good material in the steel skeleton structure, well protected with an ample thickness of terra cotta casing, and sheathed in brickwork, will stand any ordinary conflagration, and when the openings are guarded by heavy metal shutters or by wire glass, the building will resist even such a fire as took place in Baltimore, a fire far exceeding in intensity and extent anything within the ordinary bounds of probability.

BRITISH IRON-ORE SUPPLIES.

SOURCES OF IRON-ORE SUPPLY AVAILABLE FOR MAINTAINING THE OUTPUT OF BRITISH FURNACES.

West of Scotland Iron and Steel Institute.

THE question of iron-ore supply is a most important one in determining the future location of the industry. Great Britain owes much of her marvellous progress in manufactures and commerce to her supplies of iron and coal, while the rapid growth of the American iron and steel industries is largely due to the opening up of the immense resources of the northwest. In an interesting address delivered by Mr. Bennett H. Brough, Secretary of the Iron and Steel Institute, before the West of Scotland Iron and Steel Institute, the present position of Great Britain in respect of iron ore supplies is clearly discussed.

"From time to time pessimistic paragraphs are published in the papers telling us that the Bilbao mines are worked out, that other sources of iron ore supply have been secured by foreign competitors and that the home mines are no longer productive. In view of the fact that in 1902 Great Britain consumed two million tons more iron ore than in the previous year, it may be of interest to inquire to what extent such statements are accurate, and to review briefly the present sources of iron supply. The result will, it is believed, show that while it is true that the richest ores at Bilbao have been exhausted, and that more attention has been paid to calcination and to the washing of ores of inferior quality to enable them to meet market requirements, there need certainly be no immediate apprehension of a Bilbao-ore famine. Far-seeing British iron masters are, however, already making arrangements for the time when substitutes for the Bilbao iron ores will have to be found. And happily there are still large fields of ore almost untouched, in Spain and in other countries.

"A study of the world's iron ore mines presents points of great historical interest, inasmuch as the history of iron mining goes back far beyond the periods of authentic records. In Europe the rich ores of Spain and Elba were much used during the Roman period. Remains of the Roman working of iron mines have also been found in the Forest of Dean, in the Weald of Sussex, in Belgium and in Austria. Indeed, the iron left in the slag heaps of the Forest of Dean furnished the chief supply to twenty furnaces for nearly 300 years. The ancient iron masters were unable to work any but the purest ores. The introduction of coal as fuel for smelting by Dud Dudley in 1618 and by Abraham Darby in 1713; the replacement of coal by coke; the invention of the modern steam engine by James Watt in 1770, of puddling by Henry Cort in 1784, of the hot blast by Neilson in 1828, of the Bessemer process in 1856, of open-hearth steel making in 1861, and of basic steel making in 1879, are a few of the great improvements that have stimulated the iron-ore mining industry and have rendered it possible to work impure material. Indeed, improvements in the methods of mining and of smelting iron ores have followed in rapid succession, with the result that the world in 1902 produced no less than 43,475,000 tons of pig iron—the result of the smelting of 87,000,000 tons of iron ore."

The development of the iron industry during the past half century has been remarkable, both for the increase in output and the changes which have occurred in distribution. Thus, in 1854, according to Mr. J. K. Blackwell, the world's production of pig iron was 6,000,000 tons, of which the United Kingdom produced 50 per cent., France and the United States each 12.5 per cent., Germany 6.6 per cent., and the balance by the other nations. In 1902 the total output has increased to 43,475,000 tons, but the United States now leads with 41 per cent., the United Kingdom following with 19.8 per cent., and Germany and Luxemburg together following with 19.3 per cent. Thus the United States produces about as much as the United Kingdom and Germany together, these three countries making more than 80 per cent. of the world's output.

Confining himself to the subject of iron ore, Mr. Brough showed that in 1901 the world's output was 87,000,000 tons, of which the United States produced 33.7 per cent., and Germany and the United Kingdom each 14 per cent. In 1902 the United Kingdom produced 13,426,000 tons of iron ore, valued at £3,288,000.

"Even that enormous output did not meet the consumption, and 6,898,000 tons were imported. Of that amount 82 per cent. was brought from Spain, 5.2 per cent. from Greece, 3.4 per cent. from Algeria, 2.8 per cent. from Italy (Elba), 1.6 per cent. from Sweden, 1.4 per cent. from Newfoundland, and smaller quantities from France, Turkey, Germany, Portugal, Russia and Australasia. In fact, the world is being ransacked for fresh iron-ore fields to supply rich ores for the British blast furnaces. The harbour at which most of the ore was delivered was Middlesbrough (1,177,000 tons); then followed Glasgow with 919,000 tons; and then Cardiff with 818,000 tons.

In Great Britain the principal iron-ore producing districts are Cleveland, in North Yorkshire, which in 1902 yielded 40.2 per cent. of the total output of the kingdom; Lincolnshire and Northamptonshire, yielding 26.7 per cent.; Cumberland, yielding 11.7 per cent.; Scotland, 6.2 per cent.; and Staffordshire, 6.1 per cent."

While there is no doubt that the rich ores of Bilbao and Elba are becoming scarcer, there are still large quantities of ore available in the north of Scandinavia, in the south of Spain, in Algeria, Canada, Cuba, South America, India, and China. The cost of carriage must always be an important factor, but this may be reduced by the great economies which are constantly being introduced. A great feature to be considered is the more general use of the basic open-hearth process, by means of which ores containing a higher percentage of phosphorus are rendered available for steel making.

The discussion upon Mr. Brough's paper emphasised the fact as to the gradual diminution in supply of Bilbao ore. In 1899 the output of these famous mines was 6,200,000 tons, while in 1903 this had fallen to 5,000,000 tons, and was steadily diminishing. When it is considered that the deposits have already yielded 115,000,000 tons, it is apparent that the time for diminution might well be expected. The great deposits of Swedish Lapland should next be considered, and the completion of the railway from the Gellivara district to the port of Narvik renders these deposits easy of access from England. Freight from Narvik to Grangemouth at 5s. 3d. compare favorably with the rates from Bilbao to the Clyde, and if transport and handling methods similar to those used on the Great Lakes in America are adopted there need be no fear for lack of supply.

The fact that the Lapland ores contain phosphorus need not be an objection, since the basic process, an English process in origin, although used far more in other countries, is well adapted for such ores. Nearly 80 per cent. of the steel made in Germany is basic-open-hearth product from phosphoric ores, so that question may well be left to take care of itself.

VANADIUM STEEL.

CONSTITUTION, PROPERTIES, AND PRACTICAL APPLICATIONS OF ALLOYS OF VANADIUM AND STEEL.

Léon Guillet—Académie des Sciences.

ALTHOUGH frequent notes have appeared in the technical press concerning the valuable qualities of vanadium steel there has been no published record of systematic researches into its properties. For this reason the paper of M. Léon Guillet, presented before the *Académie des Sciences,* and published in *Comptes Rendus,* is of importance and interest.

M. Guillet has made investigations upon two series of vanadium steels, the first containing about 0.20 per cent. of carbon, and the second 0.80 per cent. In each series the proportion of vanadium was increased from 0 to 10 per cent., especial attention being given to those containing 3 per cent. of vanadium, as being of the greatest industrial importance.

Considering first the results of micrographic examination, M. Guillet etched specimens of the 0.20 carbon steel with picric acid, and observed no material difference from carbon steel in appearance until the content of vanadium exceeded 0.7 per cent.; the pearlite was the same in appearance as in carbon steels, but the ferrite was rapidly colored a dark brown. As the content of vanadium was increased there appeared distinct white grains in the pearlite, these being plainly visible in relief upon polishing. These white grains developed with increasing proportions of vanadium until the pearlite was no longer visible, and when the alloy contained more than 3 per cent. of vanadium the white grains alone appeared, increasing in number and magnitude as the percentage of vanadium was increased.

Similar results were obtained with the steel containing 0.80 per cent. of carbon. Up to 0.5 per cent. of vanadium the structure was pearlitic, after which the white grains appeared and rapidly increased; and above 3 per cent. nothing else was to be seen. This product is a carbide, either a carbide of vanadium or a double carbide of vanadium and iron.

Three groups may be distinguished in considering vanadium steels:

1. Steels presenting the same structure as carbon steels;
2. Steels containing pearlite and vanadium carbide;
3. Steels in which all the carbon appears in the latter form.

The mechanical properties may be stated broadly as follows:

Steels of the first and second groups show a much higher ultimate strength and elastic limit than ordinary steels of the same carbon content; the elongation and reduction of area are medium, and they are much harder and more brittle than carbon steels. Thus, a steel containing 0.131 carbon, and 0.60 vanadium showed an ultimate resistance of 98,000 pounds and an elastic limit of 78,000 pounds. With a steel of 0.112 carbon and 1.04 per cent. vanadium the ultimate strength rose to 129,000 pounds with an elastic limit of 107,000 pounds per square inch, the elongation being from 10 to 12 per cent.

Steels of the third group, containing 3 per cent. and more of vanadium show very low ultimate strength and elastic limits, the elongation becomes high, while at the same time they are very brittle. Thus a steel containing 0.187 per cent. carbon and 2.98 per cent. vanadium showed an ultimate strength of about 67,000 pounds and an elastic limit of about 27,000 pounds; while with 0.12 carbon, and 10.27 vanadium the ultimate strength fell to 43,000 pounds and the elastic limit rose to 30,000 pounds. A steel containing 0.737 carbon and 7.85 per cent. of vanadium had an ultimate strength of 43,000 pounds and an elastic limit of 19,000 pounds per square inch. For these alloys the elongation ranged from 16 to 24 per cent.

All of the vanadium-steel alloys are annealed to a slight degree by heating for a short time to a temperature of about 900° C. If the annealing is prolonged and a high temperature maintained, a precipitation of graphitic carbon occurs in a manner similar to that observed with other steels. Quenching produces a remarkable hardness in the steels of the first two groups, while it produces a slight softening of the third group. These effects appear to be produced regardless of the temperature at which the steel is quenched. M. Guillet extended his experiments in this respect up to a temperature of 1,200° C., and in no case did the quenching materially change the structure.

In general the following statements may be made concerning vanadium steels:

They may be divided into three distinct groups, one of these holding an intermediate position between the other two. Each of these groups may be characterized by its mechanical properties and those containing the special constituent present very remarkable properties. The experiments show that industrial applications may be expected only of those steels containing less than 7 per cent. of vanadium, and hence it is upon these alloys that further experiments should be directed.

The brittleness of the vanadium steels apparently prevents them from being used for the production of cutting tools, for which they would otherwise appear to be well adapted, but it is possible that this property may be modified by the addition of nickel. M. Guillet is at present engaged upon experimental researches upon nickel-vanadium steels, and promises to make his results public before long.

TRADE UNIONS AND EMPLOYERS' ASSOCIATIONS.

CONDITIONS UNDER WHICH SATISFACTORY OPERATIVE RELATIONS CAN BE MAINTAINED BETWEEN ORGANIZATIONS OF WORKMEN AND EMPLOYERS.

Charles W. Eliot—Boston Central Labor Union.

IT is not often that the president of a great university has the opportunity to address the members of a labor union, and unfortunately it does not appear that members of labor unions are generally desirous of listening to the words of eminent educators. It is therefore a matter for interested comment that the president of Harvard University delivered a thoughtful and pointed address before a powerful labor organization, and in his quiet and incisive manner told them some important truths concerning their relations to their fellow men. The address of President Eliot before the Boston Central Labor Union is to be examined as a unique example in the history of labor discussions with more than usual interest.

President Eliot does not mince matters. He admits from the start that there is a conflict, and also that the labor side has at first had the best of it. With the improvements in rapid communication the effective power of large combinations of men has been greatly increased, and the workingmen have been the first to utilize the telegraph, telephone, and quick mail service which together have made it possible for prompt, common action to be taken by men who are scattered all over the land. But the men have not been long allowed to retain their superiority in this respect, and within the past few years the employers have associated themselves in practically the same strength as the men, and have joined issue with them in various ways. In some cases the employers have simply resisted the demands of the unions, but in many instances the result of the meeting of the two organizations has been the arrangement of a joint agreement, including the acceptance of wage rates, hours of labor, recognition, etc., on one hand, and the maintenance of peaceful relations on the other. This dual combination enables the combination to control prices and maintain a monopoly in prosperous times, but it does not hang well together in dull times.

In considering this present state of affairs, President Eliot says:

"Whither does this practice tend, and what are the natural limits of its power, if any there be? Under democratic law and custom and with the facilities which modern society possesses for quick intercourse and free exchange of views, these two monopolistic combinations, the union and the employers' association, have come into existence, and are capable of uniting in a common interest. What is the limit to the successful exercise of the tremendous power such a combination of two monopolies possess? The limit, I believe, is only to be found at the limit of the consuming power of the population. That consuming power is limited. It fluctuates from year to year, but it rises in civilized countries from generation to generation, and has risen prodigiously during the past 100 years. Nevertheless, its limits are much narrower than the modern monopolists appear to suppose."

There is necessarily a third party involved in the matter, the consumer, or as Dr. Eliot calls it, the whole community, upon whom the burden must fall, but it must not be forgotten that no man can belong wholly to one party only, since all men are consumers, and must form a part of the whole community, and any combination to perpetrate wholesale injustice must react upon every member of that community.

"There is, however, some clear gain to the whole community from the progressive rise in the prices of labor and of materials since labor unions began to put up wages. Invention has been strongly stimulated thereby—the invention of labor-saving machinery and of new materials or new combinations of materials. Every such invention adds to the power of man over Nature, and some of this added power ought to be credited to the unions. At this point some enthusiastic unionist may say, organize every trade and calling, so that there shall be no non-union public to suffer from the price-raising which 20th century unionism effects. But if we try to imagine the entire community divided into trade union groups, each group containing the union and the employers' association of its trade, we immediately perceive that the attitude of each single trade group toward its consumers will remain precisely what it is now. Society will be divided into monopolistic trade groups; but each group will be trying to get higher wages and profits by raising prices on its own goods. The union label will be on all goods, and therefore of no advantage to any, and the only market will be a higgling between intrenched monopolies. A demand consisting of many unionized monopolies will encounter a supply proceeding from a single unionized monopoly. This situation is almost unimaginable."

This phase of the situation reminds one of the Irish agitators, who proposed to kill all the landlords, so that they themselves might become the landlords, after which there would be nothing left but for them to kill each other.

That there must be some sort of a remedy to the armed truce of the two opposing camps, Dr. Eliot feels sure, and naturally he looks to that feature of life in which his own work has been done to discover the remedy. As a man whose entire life has been devoted to education, he sees in the fuller education of the combatants a means by which they may be brought to dwell together in peace.

Associations, both of workmen and of employers are all right, but there is no reason why they should not exist for beneficial purposes, as well as for those which are antagonistic.

"Industries which support thousands of workmen and hundreds of employers, both workmen and employers often need to take action through representatives, and must maintain organizations capable of choosing representatives. Apart from benevolent and social objects, those two forms of association would be maintained for the principal object of determining prices—the prices which each industry would bear.

A secondary object would be to improve steadily those sanitary and educational conditions of labor which make labor more efficient and both capital and labor more productive. Those two objects are perfectly harmonious, for since wages can in the long run only be paid out of product, the economic justification of higher wages is greater skill and efficiency in the individual workman, and their social justification is the increased total efficiency and happiness of the community. The process of determining what prices a given industry will bear is now a process of combat. The weapons have been chiefly strikes, boycotts and lockouts, all of which ordinarily involve bitter strife and violence, and not infrequently the disastrous interruption of a productive industry. This is certainly a very stupid way of arriving at a determination of the best price to be got in any year or at any moment for a given product. Conference and discussion between the workman, the capitalist and the trading agent, whatever he may be called, are the rational modes of arriving at a practical answer to the question of price; and this would be the mode adopted if right relations existed between capitalist and workman, each believing that the other had a genuine interest in the real success of the business they unite to conduct."

Whether this peaceable consummation can be reached or not depends greatly upon the kind of education which is acquired by the members of the opposing camps. Knowledge is undoubtedly power, but in many cases it is power which is employed for evil as well as for good, and it remains to be seen how far a modern training will help matters. Further education is certainly necessary, but it must be of the right kind.

"You and I and everybody must, in the first place believe, and must teach our children to believe, that brave men are not mere creatures of circumstances, slaves of blind forces, or tools of destiny, but are capable of molding circumstances, directing forces and changing destiny. And then each one of us might fight evil and promote good by his own personal endeavors and sacrifices. The forces of society, which seem so strong, often turn out to be weak when confronted by men who believe with all their hearts in pure ideals of freedom and righteousness."

THE FORM OF RIVER BEDS.

A THEORETICAL VERIFICATION OF EMPIRICAL LAWS GOVERNING THE FORMATION OF CHANNELS IN SHIFTING GROUND.

Annales des Ponts et Chaussées.

IT has long been known that in rivers flowing through soft ground the form of the navigable channel is affected by the curves and sinuosities of the stream. If a longitudinal profile of the river bed is compared with a plan of the stream it will at once be observed that there is a close relation between the concave curvatures and points of greatest depth. In general, the relation between the vertical and the horizontal curvatures of the channel is such that the spacing between the apex of the horizontal curves and the points of greatest depth is practically constant, being from one-fourth to one-fifth of the distance between two consecutive shallows. This fact, which has been worked into various empirical laws, appears to be a consequence of the general principles of hydrodynamics, and the relations which may be traced form the subject of a paper by M. Fargue, in a late issue of the *Annales des Ponts et Chaussées.*

M. Fargue considers first the normal resistances to the flow of a stream in a straight channel, examining the surface curve of velocities, and the position of the line of mean velocity in the cross section. Comparing these with the forces which act to oppose them, he works out the equations which result, and shows that the actual trajectory of the centre of flow may be computed for various values of the resistances. When the path of the stream is curved, instead of being in a right line, the centre of flow is also curved, but its trajectory is deflected in two directions, both horizontally and vertically, giving a sinuous curve of double curvature. The path is thus found to be resultant of two sinusoidal curves having a definite relation to the axis of figure of the stream.

Applying the computations to a given example, it appears that the trajectory of the centre of flow is always deflected beyond the axis toward the concave face of the curve. This deflection causes a corresponding change in the position of the vertical curve, the maximum scour naturally appearing beneath the trajectory of maximum velocity. M. Fargue has compared his theoretical studies with comparative diagrams of the actual conditions on the Garonne and on the Scheldt, showing that the curve of the depths corresponds almost exactly with that of the direction of the stream, but displaced about one-fourth of the distance between maximum and minimum depths.

It thus appears that the general principles of hydrodynamics confirm fully the empirical laws which have been deduced from observation. It is, however, to be desired that a greater number of comparative observations be made, in order that the degree of approximation may be more precisely determined.

The practical bearings of these studies may readily be perceived. In the first place the old-time method of river regulation, attempting to confine a channel between rectilinear banks, is giving way to a more rational method of observing the reasons for curvature, and making use of them for controlling the direction of flow.

The manner in which depth may be caused by scour controlled by curvature has also led to a more scientific method of regulating the depth of channels, not only in the case of streams in which a definite current exists, but also in connection with tidal harbors where the entrance is obstructed by bars. Channels which are cut by dredging cannot be expected to remain if they are made in situations where the whole tendency of the natural forces is to fill them up, while if, by means of breakwaters, or similar artificial structures, a proper curvature is given to the flow the location of scour may be closely predetermined, and the channel produced and maintained by the very forces otherwise tending to close it.

Although experiments upon actual streams are to be desired in the study of the action of the current upon the bed, much may be learned in this connection by laboratory experiments. As already described in these columns, there is, in the laboratory of the polytechnic school at Karlsruhe, as well as at Dresden, an apparatus for reproducing upon a small scale practically all the conditions existing in large streams, with the added advantage of the ability to observe and record the results. By building up a miniature river channel, and constructing various deviating jetties and breakwaters, many practical problems may be reproduced and examined, so that the whole subject can be removed from the domain of hypothesis, and subjected to experimental demonstration. It is to be hoped that such experimental channels may prove as fruitful of practical results as the testing tanks have been in connection with the form and speed of vessels, and additional data obtained for working service.

THE STORAGE OF PIG IRON.

A COMPARISON OF THE CONDITIONS WHICH SURROUND THE IRON PRODUCER IN THE UNITED STATES AND GREAT BRITAIN.

George H. Hull—Iron Age.

It has often been said that the iron market is the barometer of trade, and if it be taken to mean that the iron trade is an indicator, broadly speaking, of other trade conditions, the expression is not amiss. Doubtless the use of iron is a necessity for the conduct of all other lines of work, not only for those engineering industries and enterprises which require iron products directly, but also for all the great mass of secondary occupations which follow in their train. The iron trade, therefore, feels the demand very early, and also the slackness promptly, in periods of industrial fluctuations.

In a paper published in the *Iron Age*, and expanded in a subsequent reprint, Mr. George H. Hull examines the relation between demand and supply in the iron trade, with especial reference to the storage warrant system of England and Scotland, and the possibility of its introduction into the United States.

"In Great Britain, as in the United States, all constructive projects of any considerable magnitude, such as buildings, ships and railroads, are arranged for in advance by a contract between the projector and the builder. The projector first has prepared for him plans and specifications. Copies of these plans and specifications he sends to several builders for the purpose of securing several bids on the work. Each builder makes his estimate of what the work will cost, adds to this estimate a certain percentage for his profit, and then makes a bid on the work for a certain specified sum. If the projector accepts one of these bids he then enters into a contract with the successful bidder. This contract not only embodies a price for the entire work, but usually embodies a specified time in which it is to be completed. On work of great magnitude, which will require a long time to complete and which will consume a large amount of iron, it is customary for builders in each of these countries to protect themselves against any possible loss which might otherwise come to them by means of any large advance in the price of iron during the progress of the work.

"The manner of protecting themselves against such loss which has grown up in these two countries is radically different. To illustrate this difference, we will suppose that a contract has been made in each country, which provides for certain constructive work which is to be completed within 12 months; that this work will require 12,000 tons of iron at the rate of 1,000 tons per month.

"In the United States the builder protects himself against loss by making a contract with the iron producer to deliver him 12,000 tons of iron at the rate of 1,000 tons per month at the price current at the time the contract is made. Thus the risk of loss is transferred from the builder to the iron producer, without any compensation to the producer for the risk which he assumes. Through this custom it has come to pass that the American iron producer necessarily has his future product sold to the consumer at fixed prices for many months ahead.

"In Great Britain, on the other hand, the builder protects himself against loss by making a contract with the warrant dealer to deliver him warrants for 12,000 tons of iron, at the rate of 1,000 tons a month, at the price current on the day the contract is made. This protection is furnished at a rate of charges which are as well established in that country as are the charges for life, marine, or fire insurance. Thus, in Great Britain, by legitimate business methods, the risk of loss is transferred from the builder to the warrant dealer, who receives the customary rate of compensation for the risk."

Mr. Hull discusses at length the extent to which the business of issuing and handling such warrants has grown in Great Britain, and shows how it works in practice.

"There is an impression among many that in Great Britain consumers purchase by warrant the iron they consume. This is a mistake. Consumers buy nearly all the iron they use from the makers, or their agents. They each have their preference as to the brands they use, as well as the firms they buy from. Many of these business affinities last for a life time. The warrant which the consumers contract for as a protection are to them nothing more than a protection. As the months roll by they purchase the iron or steel they wish for their work of the brand, quality and shape they require, and simultaneously sell on exchange their warrants. If iron has gone up, say 20 shillings, they pay about that much more for their material, and they get that much more for their warrants. If iron has gone down, say 20 shillings, they buy their material for about that much less and get that much less for their warrants. In this manner they eliminate any speculative element from their business and thus insure their legitimate builders' profits."

In view of the success which has attended the warrant system in England and Scotland Mr. Hull believes that its general introduction into the United States would have an excellent effect in steadying prices and preventing in a great measure the fluctuations which now occur.

That there is no danger of an overproduction of pig iron by the creation of such a means of absorbing the production is indicated by the opinions of men well qualified to judge.

"The late Hon. Abram S. Hewitt, in a paper read before the American Institute of Mining Engineers in September, 1890, predicted that this country would require 14,800,000 gross tons of iron in 1900. This was not a figment of his imagination but the result of a mathematical calculation based on the actual increase of consumption during preceding years. For 40 years Mr. Hewitt's predictions relating to consumption have been more than verified; just as this one was.

"Mr. Edward Atkinson has recently predicted that the demand for iron in the United States will be at the rate of 40,000,000 tons per annum between 1900 and 1913. This prediction, like those made by Mr. Hewitt, is based upon a mathematical calculation of the progressive increase of the past. The demand will not increase gradually, but will increase suddenly, as it always has. Does not every thinking man know that if we were to accumulate a reserve stock of 10,000,000 tons in the United States before that date it would all be consumed during the first year of prosperity, and does he not know if such a stock is not accumulated we shall have a repetition of the same woeful experiences which the iron business has gone through eight times within the last 75 years?

"There is no danger of accumulating during a dull period more than will be consumed during the period of prosperity which follows. The largest reserve stock ever accumulated in the United States by the merchant furnaces was about 1,000,000 tons, equal to but a few weeks' consumption. If the United States had held, at the close of 1897, a reserve stock of four years' production it would all have been consumed in the six years which followed, together with a current annual production of 9,000,000 tons. Think of it; restricting production, with a reserve stock of 1,000,000 tons of iron, on the eve of a period of prosperity which required an extra supply of 36,000,000 tons."

In discussing the propositions of Mr. Hull, the opinion of one of the most experienced men in the American iron market, Mr. Archer Brown, may be quoted as of interest:

"A more ingenious system for producing extreme fluctuations in prices could not well be devised than the present one. While it continues we shall, of course, have alternating periods of great prosperity and great depression. Whether the iron trade of America could be educated to the point of carrying large stocks to be dealt in on the exchanges, is a matter about which difference of opinion has always existed. If one-half the energy and capital were put into it that have been back of the movements of cotton and coffee, or even the recent upward movement in the stock market, the public would become interested as a buyer, and would find scope for its speculative instinct in something that had real and imperishable value of securities backed by wind and water."

HIGH-TEMPERATURE MEASUREMENTS.

RECENT IMPROVEMENTS IN PYROMETERS AND IN THE PRACTICAL DETERMINATION OF HIGH TEMPERATURES IN INDUSTRIAL OPERATIONS.

Verein Deutscher Ingenieure.

NUMEROUS devices have been proposed and constructed for the measurement of differences of temperature, but the most familiar forms, such as the mercury and alcohol thermometers are adapted for narrow ranges of temperature only. Wedgwood, in the course of his practical work in the production of high-grade pottery, felt the importance of accurate temperature measurements, and his efforts to devise a method based upon the shrinkage of cubes of clay when exposed to heat are well known, although they are of interest now solely from a historical point of view. The later developments of pyrometry are discussed in a paper by Dr. Ludwig Harald Schütz, in a recent issue of the ***Zeitschrift des Vereines Deutscher Ingenieure,*** from which we make some abstracts.

After describing the ordinary metallic thermometers, based on the expansion of a spiral of metals of different coefficients of expansion, Dr. Schütz refers to the improved mercurial thermometers, in which the range is increased by the introduction of compressed nitrogen or carbonic acid in the upper portion of the tube, this enabling temperatures as high as 550° C. to be indicated, although the boiling point of mercury under atmospheric pressure is only 357° C. Another device which may be found useful for temperatures above the boiling point of mercury is the so-called thalpotasimeter, in which the temperature is indicated by the pressure produced by a confined volume of vapor. In some forms of this instrument the vapor of ether is employed, while in others the vapor of mercury is used. Such instruments are provided with a dial, enabling the pressure to be read directly, as well as with a recording lever, which draws a permanent record upon a moving band of paper.

For still higher temperatures the water pyrometer is sometimes employed, this being based upon the method of mixtures. A piece of metal, such as platinum, of known weight and specific heat, is exposed to the source of heat, and is then plunged into a known weight of water. From the rise in temperature of the water the temperature to which the mass of metal has been subject may then be computed by an appropriate formula. Numerous precautions must be taken with this method if accurate results are to be expected.

A form of pyrometer now very generally used for scientific observations, as well as for important practical operations is the thermo-electric apparatus of Le Chatelier. This device is based upon the fact that when two pieces of dissimilar metals are united and the point of union is heated, an electric current will be produced. To employ this principle for pyrometry it is necessary that the substances should be capable of resisting a high temperature, and also that a moderate current only should be produced. Le Chatelier employs two wires, one of pure platinum and the other of an alloy of platinum with 10 per cent. of rhodium, these being united at one end while the other ends are connected with a galvanometer. The two wires are enclosed in a porcelain tube, which serves to protect them and facilitates their introduction into a furnace, flue or other place.

The latest methods of temperature measurement, however, are based upon a different principle, giving rise to the so-called optical pyrometers. Probably the earliest form of optical pyrometer was that suggested by Newton, associating definite temperatures with certain colors. Following out this line Pouillet determined the temperatures accompanying the more conspicuous color changes, and these have been used for a long time as giving rough approximations. An improvement on the ordinary direct observation of a glowing body was made by Mesure and Nouel in what they termed a pyrometric telescope. This consisted of a tube containing two Nicol prisms, the first being fixed and the second capable of rotation through an angle measured by a graduated circular scale. Between the two prisms is placed a plate of quartz. The light is polarized by the first prism and partly rotated by the quartz. When the second, or analyzing prism is turned through the proper angle the polarized rays of light are obstructed, and the field becomes dark. If the light under examination is mixed the successive colors will become visible according to the angle through which the analyzing prism is rotated, and the angle through which this rotation must be made to obtain a certain color depends upon the composition of the light. This latter again depends upon the temperature, so that the angle of rotation may be made a means of indicating the temperature. Although this apparatus enables closer results to be attained than is practicable by direct visual observation, yet the difficulty of deciding that a previously observed color has again been produced renders any very high degree of precision impossible.

The later improved pyrometers, however, depend, not upon light rays but upon the actual emission of heat rays from the body whose temperature is to be measured. The researches of Lummer, Pringsheim, Wien and others have made it possible to determine the temperature of the dark rays emitted by a heated body, and upon this principle the latest forms of radiant pyrometers are based.

Thus the Wanner pyrometer, which has been tested at the Reichsanstalt for temperatures between 900° and 2,000° C., showing a maximum error of less than 1 per cent., is based upon the relation existing between the absolute temperature of a body and the wave length of the emitted rays. According to the formula derived by Planck, there is a definite relation between the wave lengths of two sets of rays and the temperature of the bodies by which they are emitted, so that it is practicable to measure the relation between the temperature of an unknown body and that of one whose temperatures is known. This wave relation has been determined only for the dark rays, but it is quite possible to work with light-emitting bodies by using properly constructed apparatus.

Thus the light used for comparison may have its "black" temperature determined by previous comparison with a black substance. By then using for the comparison the waves of a single length for each substance the true temperature relation may be determined. The light used for comparison is generally an incandescent electric lamp, the rays from which fall upon a finely matted screen. The lamp used by Wanner shows by comparison a "black" temperature of 1,162° C. Waves of uniform length may be obtained either by use of colored glass or by decomposing the light by a prism and selecting a determinate portion of the spectrum, this latter being the method actually employed. The rays from both sources are passed through a direct-vision prism, and then through a Rochon prism, this latter causing polarization of the light in two directions, perpendicular to each other. The polarized light is then examined by means of a Nicol prism, and the angle of rotation required to make the two halves of the field equal in illuminating intensity is a measure of the temperature relation of the two sources. Thus the entire operation of temperature measurement consists in pointing the instrument at the source of heat and turning the eyepiece until equality of illumination is obtained over the whole field. The angle is then read off, and comparison with a previously prepared table gives the temperature.

Experiments made by Professor Wanner at the Ilse iron works showed the temperature of the flowing slag of a blast furnace to be 1,372° C., while that of the fluid iron ranged from this to 1,330°, cooling to 1,230° as it began to set in the mould. The temperature at the tuyeres, observed through the peep hole, reached 2,050° C.

SPACE DISTRIBUTION OF ENERGY.

PROGRESS IN THE DISTRIBUTION OF ELECTRIC ENERGY OVER THE SURFACE OF THE EARTH WITHOUT WIRES.

Nikola Tesla—Electrical World and Engineer.

THERE are a number of interesting and valuable articles in the recent anniversary issue of the *Electrical World and Engineer*, many of these over the names of men famous in all lines of electrical work. A large proportion of the papers, however, are historical and retrospective in their nature, and as such valuable mainly as matters of record. Among them, however, is a communication from Mr. Nikola Tesla, which is especially interesting as the first authoritative communication from him for several years in connection with his experimental work in connection with the electrical distribution of energy through space without the use of metallic conductors.

The success which has attended the employment of various methods of space telegraphy has prepared the public mind for a realization of the fact that wires are not necessary for the transmission of electric energy in such moderate amounts as may be necessary for purposes of communication over long distances, so that the extension of the subject to the distribution of energy in greater degree is not altogether incredible.

Mr. Tesla describes the laboratory which he established near Colorado Springs in 1899, this being equipped with instruments for investigating, among other things, the electric potential of the globe. This apparatus consisted of a highly sensitive self-restorative device, controlling a recording instrument, this being included in a secondary circuit, while the primary was connected to the ground and to an elevated terminal of adjustable capacity. The variations of potential gave rise to electric surgings in the primary, and these generated secondary currents, which in turn affected the sensitive device and recorder in proportion to their intensity. With this apparatus the earth was found to be filled with electric vibrations, and these were thus subjected to continual observation and study.

One especial observation, made during and after a heavy thunder storm directed the attention of Mr. Tesla to a phenomena which he may best be allowed to describe in his own words:

"The recording apparatus being properly adjusted, its indications became fainter and fainter with the increasing distance of the storm, until they ceased altogether. I was watching in eager expectation. Surely enough, in a little while the indications again began, grew stronger and stronger, and, after passing through a maximum, gradually decreased and ceased once more. Many times, in regularly recurring intervals, the same actions were repeated until the storm, which as evident from simple computations, was moving with nearly constant speed, had retreated to a distance of about three hundred kilometers. Nor did these strange actions stop then, but continued to manifest themselves with undiminished force. Subsequently, similar observations were made by my assistant, Mr. Fritz Lowenstein, and shortly afterward several admirable opportunities presented themselves which brought out still more forcibly and unmistakably the true nature of the wonderful phenomenon. No doubt whatever remained. I was observing stationary waves.

"As the source of disturbances moved away the receiving circuit came successively upon their nodes and loops. Impossible as it seemed, this planet, despite its vast extent, behaved like a conductor of limited dimensions. The tremenduous significance of this fact in the transmission of energy by my system had already become quite clear to me. Not only was it practicable to send telegraphic messages to any distance without wires, as I recognized long ago, but also to impress upon the entire globe the faint modulations of the human voice, far more still, to transmit power, in unlimited amounts, to any terrestrial distance and almost without any loss.

"With these stupendous possibilities in sight, with the experimental evidence before me that their realization was henceforth merely a question of expert knowledge, patience and skill, I attacked vigorously the development of my magnifying transmitter, now, however, not so much with the original intention of producing one of great power, as with the object of learning how to construct the best one. This is, essentially, a circuit of very high self-induction and small resistance which in its arrangement, mode of excitation and action, may be said to be the diametrically opposite of a transmitting circuit typical of telegraphy by Hertzian or electromagnetic radiations. It is difficult to form an adequate idea of the marvelous power of this unique appliance, by the aid of which the globe will be transformed. The electromagnetic radiations being reduced to an insignificant quantity, the proper conditions of resonance maintained, the circuit acts like an immense pendulum, storing indefinitely the neergy of the primary exciting impulses and impressing upon the earth and its conducting atmosphere uniform harmonic oscillations of intensities which, as actual tests have shown, may be pushed so far as to surpass those attained in the natural displays of static electricity."

Mr. Tesla illustrates the central power plant and transmitting tower already constructed on Long Island, from which he expects to be able to send out waves for the transmission of messages in all directions, these to be received by a number of receiving instruments. The general idea, as advanced in Mr. Tesla's paper involves the employment of a number of plants, all of which are capable of transmitting individualized signals to the uttermost confines of the earth. Each of them will be preferably located near some important center of civilization and the news it receives through any channel will be flashed to all points of the globe. A cheap and simple device, which might be carried in one's pocket may then be set up somewhere on sea or land, and it will record the world's news or such special messages as may be intended for it. Thus the entire earth will be converted into a huge brain, as it were, capable of response in every one of its parts. Since a single plant of but one hundred horse-power can operate hundreds of millions of instruments, the system will have a virtually infinite capacity, and it must needs immensely facilitate and cheapen the transmission of intelligence.

So far as the actual transmission of electrical energy for purposes other than the sending of messages is concerned, Mr. Tesla is also maturing plans for its exploitation. A plant is now being designed to be operated in connection with the Canadian Niagara Power Company, from which ten-thousand horse-power is to be distributed under a tension of one hundred million volts.

"This energy will be utilized all over the globe preferably in small amounts, ranging from a fraction of one to a few horse-power. One of its chief uses will be the illumination of isolated homes. It takes very little power to light a dwelling with vacuum tubes operated by high-frequency currents and in each instance a terminal a little above the roof will be sufficient. Another valuable application will be the driving of clocks and other such apparatus. These clocks will be exceedingly simple, will require absolutely no attention and will indicate rigorously correct time. There are innumerable devices of all kinds which are either now employed or can be supplied, and by operating them in this manner I may be able to offer a great convenience to the whole world with a plant of no more than ten thousand horse-power. The introduction of this system will give opportunities for invention and manufacture such as have never presented themselves before.

"Knowing the far-reaching importance of this first attempt and its effect upon future development, I shall proceed slowly and carefully. Experience has taught me not to assign a term to enterprises the consummation of which is not wholly dependent on my own abilities and exertions. But I am hopeful that these great realizations are not far off, and I know that when this first work is completed they will follow with mathematical certitude."

MAIN-LINE ELECTRIC TRACTION.

THE CASE OF THE INDEPENDENT STEAM LOCOMOTIVE AGAINST THE ELECTRIC MOTOR AND THE STATIONARY POWER HOUSE.

R. Bonnin—La Revue Technique.

WE have referred more than once in these columns to the possibilities of the successful application of electric traction to main line railways, showing that the change must be expected to develop gradually from the tramway and interurban railway, as the pressure for improved service becomes effective. The whole question is discussed from a conservative standpoint in recent issues of *La Revue Technique* by M. Bonnin, and the judicial nature of his treatment renders it especially applicable at a time when undue haste might prove prejudicial.

In treating of this important subject M. Bonnin at once disclaims any intention of treating of urban and local tramways, admitting that experience has shown these to be served far better by electric traction than is possible by steam locomotives. It is for the main lines of steam railways, operated under existing conditions, in which a limited number of express trains are intercalated between accommodation and freight trains of various speeds, that the problem of a change of motive power must be considered. Two questions enter into the solution of this problem—one, the question of cost, both of installation and of operation; the other, of the methods which may properly be applied to the use of electric traction for main-line railway service.

Since the second question has much to do with the reply to be given to the first, it may be considered before attempting to make a decision. Although the continuous current has shown itself especially applicable to local tramway systems of moderate length, it becomes too expensive to be employed for long lines without important modifications. The high-tension alternating current alone offers practical opportunity for the transmission of the necessary quantity of energy over the required distances, and this current must either be used in its original form, with or without reduction in pressure, or converted by proper machinery into a continuous current at properly located sub-stations. Both methods have been successfully employed, but the advantages of using the alternating current either in polyphase motors, such as have been used on the Burgdorf-Thun railway, in Switzerland, or the Valtellina road in Northern Italy, or in single-phase motors of more recent design, is becoming apparent. Although M. Bonnin discusses especially the value of the polyphase system, it is evident, as noticed in these columns last month, that the single-phase motor is destined to be the most advantageous for the purpose. In any case the current must be conveyed along the entire length of the line, either through overhead wires, or by means of the third rail, the latter being now generally used for heavy currents. Taking into account even the best of the figures for these methods of transmission, M. Bonnin considers that the cost of installation must play an important part in the charge for equipment.

Admitting that the current can be properly transmitted and delivered, the advantages to be derived from the use of electric traction are to be weighed. One of the chief of these is the rapid acceleration attainable. There is no doubt that electric trains can be started very promptly and caused to attain full speed rapidly, this fact being mainly due to the superior adhesion obtained with the multiple-unit system, in which all the cars are propelled, thus distributing the effort among a great number of wheels. In the case of steam locomotives the acceleration is limited by the adhesion of the locomotive, and with heavy trains it is necessary to start slowly in order to avoid slipping the driving wheels. Special locomotives, constructed for the rapid handling of light trains for local traffic, have been found capable of a high degree of acceleration, and electric locomotives, hauling heavy trains, would be under the same disadvantges as steam engines under similar conditions.

An important advantage which has been urged for electric traction is the absence of reciprocating parts, and consequent freedom from vibration. While this advantage is not to be undervalued, it must be remembered that the modern four-cylinder compound locomotives can be so effectively counterbalanced that the vibration becomes almost inappreciable, so that this point becomes of minor importance in the comparison.

It has been argued for the use of electric traction that the advantage of transferring the generation of power from the moving machine to the stationary power house is a great advantage. Considered by itself this is doubtless true, but it cannot be so considered. The cost of transmission and application must be taken into account, and under such conditions as obtain in long-distance, intermittent transport, such as must exist on the greater part of the main railways, these become matters of controlling importance.

From the examination of a number of installations, M. Bonnin deduces that the actual cost of the power delivered at the driving wheels of the locomotives is about 15 per cent. higher for electric traction than for independent steam locomotives, and that in many cases it may rise as high as 45 per cent. greater. This is a matter which is so dependent upon operative conditions that it cannot be reduced to any definite relations. For a high traffic density there is every reason to believe that electric traction is more economical than steam locomotives, and the experience of the elevated railways in New York may be taken as sufficient demonstration of this truth. For longer distances, lighter traffic and fewer trains, however, the matter is reversed. With steam locomotives the cost is practically measured by the train-mile, but with a fixed plant equal to the whole maximum capacity of the road, as would necessarily be the case with electric traction, the proportion of fixed charges would be vastly greater and the train-mile as a measure of cost would disappear. To be profitable such a line must be worked continually at or near its maximum capacity, a most desirable thing, but not a matter which can readily be controlled.

Ultimately electric traction will play an important part in main-line transport, but its immediate applications must be found principally upon the more crowded lines in the vicinity of great cities.

M. Bonnin's conclusions naturally follow from his premises, but it is a question whether his premises are those which will actually regulate the matter. It is far more probable that the introduction of electricity as a means of transport will proceed along altogether different lines from the methods which have preceded it. Railways did not follow the precedents existing in connection with the stage-coach service, except in some minor details, such as the arrangement of compartment carriages in European railways, and the like. Just so it may be expected that electricity will not make its way merely as a substitute for steam locomotive traction, but rather become the beginning force of some totally different system. What that system shall be remains to be seen. The possibility of admitting all sorts of mechanically-propelled vehicles to greatly improved highways is the possible development along what may be termed the individualistic system. The other extreme may be collectivist, so to speak, in the form of great trunk lines of continuously traveling platforms, like flowing rivers of merchandise and humanity, never stopping, but collecting and discharging its burdens *en route*. Which of these shall prevail, or what other system may appear cannot now be predicted, but it is almost certain that the older methods will be altogether transformed, and that electric power will capture them rather than be itself appropriated.

ELECTRICITY IN MINES.

REPORT OF THE HOME OFFICE COMMITTEE UPON THE SAFE USE OF ELECTRICITY IN MINING OPERATIONS.

Colliery Guardian.

FOR more than a year an important committee has been engaged in investigating the conditions under which electric transmission of energy may safely be used in mining operations, and the report of this body to the Home Secretary has recently been made public.

The work of the committee has included hearings of opinions from scientific experts and makers of electrical apparatus, colliery proprietors, miners, and insurance representatives, together with experimental demonstrations of the working of apparatus, ignition of explosive mixtures, and practical workings of machinery in existing colliery installations, and the work appears to have been very well done. The length of the report prevents its publication here, but an abstract of the main conclusions is given.

In the first place, the committee was impressed with the fact that electricity possesses such advantages that its general use in mines must become general, and hence the only question lies in the prevention or minimising of the dangers which may accompany its use. In this respect it is pointed out that the dangers involved in the employment of electricity are no greater than those due to other appliances, such as steam machinery, mining explosives, and the like. At the same time the use of electricity adds one more to the dangers of mining work, and every possible precaution should be taken in its use. In this connection, however, it must be remembered that the presence of a supply of available power will relieve miners from much severe and dangerous manual labour, so that the use of the electric current removes some sources of danger, even if it may add others.

The first point which is emphasised in the report is the importance of having first-class material and workmanship. In many existing installations the plant has grown from small beginnings, the additions having been made without proper regard to the safety of the whole. Such a state of affairs necessarily accompanies the pioneer stage of the work, but it should no longer be tolerated. But a small portion of the prime cost is saved by bad work, while the loss from a single accident might destroy the whole. For this reason the committee thinks that electricity, like high explosives, should always be considered as a source of potential danger, and hence that it should be originally of good quality, and subjected to periodical tests, while being at all times under the care of competent persons.

So far as pressure is concerned, the idea that there is safety in low voltages is not sustained; 650 volts is permitted at the face, while higher pressures are permitted in other parts of the mine. No especial location for cables is given, owing to the different working conditions in different mines, but good insulation is required, and every possible protection against external injury, together with convenient access for examination and repair.

The report is decidedly favorable to the use of three-phase motors for mining use, largely because of the absence of commutators and freedom from sparking. Doubtless the improvements in single-phase motors which are rendering them suitable for tramway use will also make these available for mining work, a most desirable solution of the question. Stationary motors should be inclosed, and so placed that they may be efficiently ventilated with intake air. By placing the machines in a closed room, free from the dangers involved in contact with air which has passed through the mine, the use of flame-tight casings is rendered unnecessary. Uninflammable materials should be used as far as possible in the construction of motor rooms, and the measuring instruments placed in the room, where they can readily be seen by the attendant.

Numerous attempts have been made to design motors which may be safely operated in an explosive atmosphere, but such a performance must necessarily be risky, and while every care should be taken to provide against the possibility of the ignition of gases, such working should be discouraged. The presence of gas can readily be ascertained by the use of a safety lamp, and the machines should be immediately stopped until the gas has been removed.

Electric locomotives, although most convenient for mining service are to be considered only for mines free from firedamp, the inevitable sparking at the trolley contact rendering them inadmissible where there is danger to be apprehended from the ignition of gas.

Electric lighting has already been well regulated by the rules prepared by the Council of the Institution of Electrical Engineers, and to these there need only be added the precautions involved in the possible ignition of gas. Experiments have demonstrated that if the bulb of an incandescent lamp is broken in an explosive mixture of air and gas the gas will generally be fired. Lamps should therefore be protected with strong glass globes, when the danger becomes less than with the ordinary safety lamps.

The advantages of the use of electricity for shot-firing and for signalling are so generally accepted that it was only necessary for the committee to formulate rules for their regulation, although the former of the two matters also comes within the scope of the regulations for explosives in coal mines.

It has undoubtedly been most difficult for the committee to deal closely with the details of installations so necessarily varied as must exist in mines. Much must be left to be determined by the local conditions, but there is every reason to believe that if the instructions are carried out in the spirit in which they have been framed, and every effort made to use the best appliances in properly skilled hands, the use of electricity in mining operations will add no new dangers of importance, and may remove existing ones of greater moment.

PRODUCTION AND APPLICATIONS OF OZONE.

RECENT PROGRESS IN THE CONSTRUCTION OF GENERATORS AND IN THE USE OF OZONE IN THE ARTS.

Marius Otto—Société des Ingénieurs Civils de France.

THE bleaching and sterilising effects of ozone have long been known, and numerous laboratory experiments have been devised for illustrating these properties. More recently ozone has been used for the purification of drinking water, and we have reviewed in these columns the work of Abraham, Marmier, Erlwein, Andreoli, and others. There appears to be no doubt as to the sterilising effect of ozone upon pathogenic bacteria contained in water if proper devices are employed for effecting intimate contact of the particles and the principal question at issue in relation to the practical operation of the process lies altogether in the cost. For this reason the paper of M. Marius Otto, recently presented before the Société des Ingénieurs Civils de France is of present importance, treating, as it does, not only of the commercial applications of ozone, but also of methods of generating it at moderate expense.

M. Otto touches briefly upon the subject of statical ozonators, cooled either by water or by air, and then passes to the more practical question of the design and operation of rotary generators for producing ozone in considerable quantities at commercial prices.

Briefly, ozone is produced by the condensation of atmospheric oxygen by the action of silent discharges of high-tension electricity. When two electrodes are placed upon glass plates so that high tension discharges pass from one to the other, the air between them becomes ozonized. If a flow of air is maintained the air charged with ozone may be drawn off continuously and diverted to the desired application. The practical difficulties are found, first in the heating of the electrodes, and second, in the tendency to form arcs and short-circuit discharges. Under such conditions it becomes difficult to operate the apparatus continuously and at a high rate, restrictions which materially affect the cost of the product.

The rotary generators, as described by M. Otto, are based upon the principle of movable electrodes, the discharges passing directly between the metallic surfaces without the interposition of any dielectrics. By keeping the parts constantly in motion a high density and large output may be maintained without the formation of arcs or sparking discharges. It is evident that this principle may be used in a variety of ways; one of the forms described by M. Otto consisting of a number of sheet-iron discs mounted upon a vertical rotating shaft within a cast-iron cylinder, the discharges passing from the discs to the interior of the cylinder, and the flow of air to be ozonized being through the interior of the cylinder. With such an apparatus, which may be made of large size and capacity, the cost can be lowered by the production of ozonized air in bulk, and its industrial applications widely extended.

The experiments of M. Otto have shown that for sterilising and bleaching purposes a high degree of concentration is not necessary, and that from 1.5 to 2.5 grammes of ozone per cubic metre of air is a satisfactory proportion. The quantity of ozone absorbed by a cubic metre of water in producing a complete sterilisation is very small. Even when a large proportion of germs are present the actual amount of organic material to be oxidized is exceedingly low. According to the experience of M. Otto a proportion of 0.5 to 0.8 gramme per cubic metre of water is sufficient, and this is borne out by the experiments of Dr. Erlwein.

The cost of production naturally depends upon local conditions, and accurate figures can be obtained only after greater experience with large installations has been had. M. Otto states that the actual cost of the electrical energy is less than 0.01 franc per cubic metre, while the results of the installation at Wiesbaden show a cost of 0.4 pfennig per cubic metre. The establishment and operative charges other than that for power depend upon the manner in which the business is managed. Taking the installation at Wiesbaden, under the management of Dr. Erlwein, for the sterilization of drinking water, the total cost per cubic metre is given at 2 pfennigs, of which 0.4 pfennig is for electrical energy, 1 pfennig for operative expenses, and 0.6 pfennig for depreciation and interest. This corresponds to a little less than 2 cents per thousand U. S. gallons, a figure which may safely be used for similar installations elsewhere.

The method of sterilising water in quantity consists in using a preliminary rapid sand filtration to remove suspended inorganic impurities and a portion of the bacteria, and then causing the water to descend through a tower filled with broken porous material, such as coke, against an ascending current of air charged with ozone. The air which has been used should be returned to the ozone generator, as it is still partly charged, and a distinct economy is effected by using it again. M. Otto describes a variety of small ozonizers, or, as he calls them, "electric filters," these being arranged to bring the water into contact with ozone as it is drawn from the tap. Such devices are well adapted for household use as well as for hospitals, and in most cases they are intended to be operated in connection with small statical ozone generators, although the larger rotary machines may be used when occasion warrants it.

An interesting application of ozone is found in Paris in connection with laundry operations. The soiled linen is first placed in large vessels, which are closed and steam admitted to moisten the articles. A current of ozonized air is then passed through the vessel, thus effectively sterilising and whitening the articles. After the washing, the clothes are dried in an atmosphere charged with ozone, which effects a final bleaching, without the slightest injury to the material. The importance of such a system in connection with hospital work, or in time of epidemics can readily be seen, and in any case such a method of cleansing and whitening is greatly to be preferred to the use of strong alkalies and bleaching agents containing chlorine.

TECHNICAL TRAINING IN THE WORKSHOP.

HOW THE SCIENTIFIC GRADUATE IS BEING UTILISED IN THE DEVELOPMENT OF MANUFACTURING AND INDUSTRIAL ESTABLISHMENTS.

R. Mullineux Walmsley—Institution of Electrical Engineers.

AMONG the various reports which have been made of late in England upon the nature and value of technical training in other countries, may be noted the extensive paper of Dr. R. Mullineux Walmsley to the Institution of Electrical Engineers, discussing Transatlantic engineering schools and engineering. Although the entire paper contains much valuable and interesting matter concerning technical training in America, it is impracticable, in view of the large amount of attention which has been given to the subject in these columns, to review this portion here. There is, however, in the report some very valuable matter relating to a side of the subject which has not been as fully discussed as its importance demands, viz., the use to be made of the technically trained man when you have got him.

After having described very thoroughly the training which is given in the best scientific schools of the United States and Canada, Dr. Walmsley proceeds to examine the "product" of such a training, with a view to the determination of the best applications which can be made. Dr. Walmsley truly says that the chief value of a technical training, such as is given in these institutions, lies, not so much in the actual detailed information which the student acquires as in the grip of fundamental principles, and an alertness of mind which enables the possessor, almost unconsciously, to apply those principles to any problems as and when they arise.

"In addition, he should acquire the attitude of a mind which is never content with the beaten track, although that track may be a good one, but is always on the lookout for fresh and more advantageous developments, and is willing to face the risk of failure which new developments, however scientifically directed, may involve.

"Such an attitude of mind, together with the fundamental knowledge which alone renders it of value, the writer believes is acquired by a fair number of the graduates of the most up-to-date institutions in the United States and Canada; and the employment of such trained talent in the industries in which science and its applications play an important part cannot but have a marked effect upon real progress.

"It remains therefore to inquire whether this talent and intellect when trained is, as a matter of fact, drafted into the service of the engineering industry, and in examining this question the writer carried his inquiries to the two principal classes of people who were likely to know the facts, namely, to the principals and the deans of the engineering faculties of the universities and colleges visited, and to the employers of engineering labour on an extensive scale to whom the majority of the graduates must look for at least the commencement of their careers subsequent to leaving college. Without exception the officials interviewed asserted that, far from having any difficulty in placing the graduates turned out year by year from the engineering courses, for the last few years the graduate class has had every one of its individual members engaged for remunerative work before the completion of the course at the college. Inquiries amongst managers and employers confirmed this claim advanced on behalf of the colleges, though in some instances a doubt was expressed as to whether in the case of the less known and more academic of the institutions the claim could be fully substantiated, but in these cases, however, it was conceded that the best graduates had no difficulty in obtaining positions, and it was only the tail-end of the class which might have to wait for some months or even abandon the attempt to get immediately remunerative employment."

In many of the larger establishments, such as the Westinghouse Company, and the General Electric Company, none but engineering graduates are taken at all as pupils, and in no case is any premium required, but, on the contrary, a living wage is paid from the start.

The wisdom of this plan appears in the fact that within a year or two at most these young men have earned promotion and are earning substantial salaries because of the value which they have shown in their services to their employers.

This is in marked contradiction to the practice in Great Britain. How can the benefits of technical training be realized by the nation when the products of such training, the men themselves are not welcomed into the shops and given opportunity to apply their trained ability to productive work? The influence of the American system cannot be traced directly, but it can by inference, as Dr. Walmsley well shows, from its connection with the engineering industry of the country.

"That this influence must be great is shown by several methods of deduction:—

"First:—That the employers liberally support the schools by taking their graduates, by giving facilities to the undergraduates for work in their vacations, and last, but not least, by liberally contributing towards equipment.

"Secondly: — That the graduates are taken on at a living wage, *no premium being required,* and that a fair chance is given to capable men to rise irrespective of family or other influence.

"Thirdly:—To any one who has walked through any of the large electrical engineering works, the presence of the experimenter and his testing staff in every part of the works shows that the brains drawn from the colleges are being utilised.

"Fourthly:—The rapid development of the engineering industries in the United States during the last ten years warrants at least the cautious deduction that this development is due to some extent to the utilisation of the brains trained in the schools, though, of course, the older men who have directed the movement had not, in many cases, the advantage of a college education.

"Fifthly: — Incidentally the quickness with which any new idea, wherever originating throughout the scientific or engineering world, is taken up and worked for all that it is worth in America, may be held to be fair evidence of the influence of the college-trained graduate, well posted in the literature of his special branch of engineering, and keenly alive to all discoveries."

Applying the result of his investigations in America to the situation in Great Britain, Dr. Walmsley shows that improved methods of training and preparation are needed at home, but he also emphasizes the fact that the most is not being made of existing opportunities and men. There is much good material available, more than is at present being used. British deficiencies are classified as follows:

"First:—In the lack, by many of our leading manufacturers of support and encouragement of the work of the colleges, either by offering positions to the best college graduates to start their works training at a living wage, or by actively assisting the colleges in the same ways as their American competitors. The attitude of the British employer toward the college-trained men is greatly influenced by the premium system which so largely prevails in this country, for in many cases the first question asked from a young man who seeks to enter the works of an engineering firm is, not what his previous training has been, but what premium his friends are prepared to pay. Cases in which pupils offering a premium are refused, because of their lack of training, are probably few and far between. Worse still, in many cases the only advantage the pupil purchases with his premium is having the run of the shop or works without any real discipline, on the off chance that he will "pick up" the necessary knowledge and experience. What struck the writer most in his investigations in America was the entire absence of this system, and the prevalence in its place of the system of offering to the college-trained men commencing positions at a living wage, and the almost universal comment of the employers that it *paid* to do this. It is not too much to say that the existence of the premium system in this country acts as an incubus upon the supply of brains for the engineering industries. The vested interests involved, however, are so great, that it is only an overwhelming sense of the importance of the subject that induces the writer, with much trepidation, to give expression to his convictions, the result of careful examination and study.

"Secondly:—Even were the employers prepared to take students on the same relative scale as their American competitors, our present schools are neither equipped nor staffed to produce in sufficiently large numbers the trained men who would be demanded. But, as it is, the best products of our existing schools do not get that encouragement at home which should be forthcoming, and a fair proportion find in the States the opportunities which are denied to them at home. The writer found not a few instances of men trained at the Central Technical College, and elsewhere, holding their own well against the graduates of American colleges.

"Thirdly—and in great part as a consequence of the first point noted, parents and guardians in this country have not yet been educated to understand how essential, in view of the great developments during recent years, college training is to the success in the future of a candidate for the engineering profession. Influenced by the well-known arguments about the advantages of so-called "practical" training, they pay the premium demanded in the fond hope that they have provided the youth with a secure path to professional success in life. The frequent disillusion at the end of the apprenticeship term is pitiable, and the writer has met with many cases in which it might be fairly described as heart-breaking."

To sum up, it will be noticed that under each head it is the employers and manufacturers who hold the key to the position, and it is for them to say whether the leeway is to be made up within this generation or postponed until it is too late. Vested interests are the greatest difficulty, but is it too much to hope that they will not continue to block the way?

SUBMARINE CABLES IN WAR TIME.

CABLE COMMUNICATION WITH THE FAR EAST AND THE METHODS OF MAINTAINING COMMUNICATION DURING THE WAR.

The Electrician.

APPLIED science enters into all departments of life and work, and rules which have been formulated for older conditions have to be modified continually in accordance with the changes which are continually taking place.

An interesting example of the manner in which modern appliances enter into politics is seen in the question of cable communication with those parts of the world which are affected by the war between Russia and Japan. From a discussion in a recent issue of the *Electrician* we abstract some notes upon this matter.

At the time of the laying of the Pacific cable it was noted in these columns that there was a certain degree of protection in the construction of lines which included terminals upon the territory of various nations, because of the fact that all such powers would be interested in maintaining open communication. A similar opinion now appears to exist in other quarters. The *Electrician* calls attention editorially to the fact that a Russian or Japanese ship attempting to cut an English cable landing on neutral territory only would be acting in defiance of international law, and theoretically be committing an act of piracy.

In the East at the present time cables connecting Japanese and Russian territory have been interrupted, although they were owned by British companies. Japan, however, is connected to the mainland by way of Formosa and China, and by way of Corea, both of these being Japanese government cables. There is every reason to believe that these cables will be subject to attack by Russia and of defense by Japan, and it remains to be seen how vulnerable a cable really is under such conditions. Japan possesses a cable ship which is capable of repairing any damage which may be done, while Russia has no such vessel at the scene of conflict, but as her efforts will be directed mainly to destruction and not to repair work, this point is of minor importance.

If the plan of the United States government to make telegraph connection between Japan and the island of Guam, on the route of the American Pacific cable is carried out, Japan will not be isolated even if all the other cables are cut.

In this connection the extent to which a cable by the northern great circle route would have entered into the situation may be noted. Although the line, as shown by Mr. Emerson in the issue of this Magazine for November, 1899, included a touch at Cape Lopatka, in Russian territory, this might have been passed by upon emergency and Japan reached direct from the island of Attu, with a line which Russia would scarcely have ventured to interrupt. That such a line may yet be constructed is within the bounds of possibility, and if Japan should be successful in her present struggle it may be begun from that end of the route.

The possible interruption of communication in war time, however, cannot but stimulate the introduction of systems of space telegraphy which, communicating through the ether, shall be without tangible material for destruction by the enemy. Already it is reported that the entire Japanese fleet is equipped with wireless apparatus, and the proximity of the Japanese islands to the American possessions in Alaska and the Aleutian islands makes it possible that a chain of Marconi stations may replace any metallic connection. The right to maintain communication is one which all nations will maintain to the best extent of their ability, and if the less civilized powers attempt to interfere with that right, the scientists and engineers of the world will see to it that such attempts are rendered unavailable.

THE STEAM TURBINE PROBLEM.

METHODS OF UTILIZING DIRECTLY THE ENERGY OF A STEAM JET DISCHARGING INTO A VACUUM.

H. F. Schmidt—American Electrician.

THERE is evidently little doubt in the mind of most steam engineers that the steam turbine is destined to replace the reciprocating engine for very many purposes, and the question to be discussed is rather the best form of steam turbine to be adopted. All credit must be given to Mr. C. A. Parsons for the ability and energy which he has brought to bear upon the solution of the question, and his work must always remain as that of a pioneer in this important field. The problem has broadened out, however, and has become a question for general discussion and application, and the paper of Mr. H. F. Schmidt, in a recent issue of the *American Electrician,* is an excellent contribution to the subject.

Mr. Schmidt begins by a mathematical examination of the action of a steam jet, deriving fundamental formulas for turbines, these being primarily in the form suitable for simple machines, and then expanded to render them applicable to multiple-stage turbines.

Assuming an initial pressure of 150 pounds per square inch absolute, and a pressure of one pound absolute in the condenser, a velocity of 3,950 feet per second results for the jet of steam.

"This enormous velocity is almost 75 per cent. greater than that of a shot from one of our large modern rifles. In order to obtain maximum efficiency, the velocity of the buckets must be half this value, which is so great that even the most tenacious material known could not withstand the resulting centrifugal strain, even though the wheels were made of large diameter. How to obtain with this enormous jet velocity the maximum efficiency without having prohibitory bucket velocity is the problem.

"This has been accomplished in two general ways, in both of which a series of revolving bucket wheels and stationary guide blades are grouped alternately. These methods are broadly represented by the Parsons turbine, which is of the reaction type, and the Rateau and Curtis turbines, which operate on the impulse principle. Each of these turbines accomplishes the desired result by reducing, in stages, the velocity of the issuing jet of steam. The bucket wheels do not travel at one-half the velocity of the jet, but considerably less, so that the fluid leaving the buckets has a backward velocity relative to the revolving wheel. If it be reversed in direction by a set of guide blades, it may be caused to impinge on a second set of buckets, and so on, until the velocity is practically reduced to zero. In the Parsons turbine, the steam enters the first set of buckets without having been considerably expanded and at a comparatively low velocity; expansion takes place continuously through the buckets and guide blades, and as the velocity is being constantly reduced by expansion, it is at the same time being constantly reduced by its passage through the buckets till at last it leaves the turbine almost devoid of motion. Hence, it is evident that as the velocity of the fluid through the turbine is almost constant, and the volume of the fluid is constantly increasing, the area through the buckets and guide blades must be correspondingly increased; and as with this system the entire circumference of the wheels must be used, in order to avoid making the blades of too great radial depth, the diameter of the wheels must be increased from the admission to the exhaust end of the turbine. In this type, the buckets are filled with expansive fluid, which on account of the difference in pressure between adjacent rows of buckets will tend to leak around the moving and stationary blades; it is necessary to have the clearance spaces between the stationary and revolving parts as small as possible in order to avoid excessive leakage."

The principal difference between the Rateau and the Curtis turbines is that the latter has reduced the large number of stages originally employed by M. Rateau to four or more, M. Rateau having used as many as twenty-five. M. Rateau applied the multiple-expansion system to the simple turbine of De Laval, and Curtis has followed in the same line.

"The losses in the turbine, as in all machines, may be divided into two classes—the inevitable and those which may be reduced by improvement in design and construction. It is therefore well to separate them in considering turbine construction. Taking up the various sources of loss in the turbine in the order that they appear in passing from the supply main to the exhaust, the first part to be considered is the nozzle. Here there cannot be any considerable thermal loss as the area from which radiation can take place is extremely small in comparison to the heat energy of the medium passing through it in a unit of time. Nevertheless, losses occur here due to the friction of the fluid on the sides of the orifice, and, owing to the reduced sectional area of the nozzle in comparison with that of the main supply pipe, eddies are formed which materially reduce the velocity of the jet. The greatest loss here is caused by incomplete expansion of the medium in the nozzle as it is impossible to reduce the final pressure below a certain value for practical reasons. Next in order, as the working fluid passes through the turbine, it passes through the buckets. Since the buckets or vanes are constantly passing the nozzles, the jet must enter and leave the vanes from either the top or the sides; hence there will be an unavoidable loss here, which is considerable. In passing through the buckets, losses occur due to friction and on account of the formation of eddies. The first cannot be reduced to any great extent, but the second can be reduced very materially, the best shape for the buckets being determined experimentally. For the reaction type of turbine the cross-section of the buckets should be parabolic, and for the impulse type, circular. In both cases, the edges of the buckets should be tangent to the direction of the jet.

An interesting application of the turbine, to which Mr. Schmidt does not refer, is that of Rateau in employing the low-pressure turbine to be operated with the low pressure steam discharged by a high-pressure reciprocating engine. In this way a large portion of the energy remaining in the exhaust of pumps, hoisting engines and similar machines may be converted into useful form, and the possibilities of the turbine for this work should not be overlooked.

THE ENGINEERING INDEX

"THE KEYSTONE IN THE ARCH OF APPLIED SCIENCE."

The following pages form a DESCRIPTIVE index to the important articles of permanent value published currently in about two hundred of the leading engineering journals of the world—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every article.

(1) The full title,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published.

We supply the articles themselves, if desired.

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer and works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of any article referred to in the Index, together with all illustrations, can usually be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the journals indexed are given.

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Saving a Sinking Concrete Arch Bridge. Illustrates and describes the method adopted for saving a bridge at Mamaroneck, N. Y. 800 w. Eng Rec—Feb. 6, 1904. No. 60668.

The Arch Bridges on the Albula Railway (Die Gewölbten Brücken der Albulabahn). With details and photographs of the important masonry arches on the line of the new Engadine railway, in Switzerland. Three articles, 3000 w. Schweiz Bauzeitung—Jan. 16, 23, 30, 1904. No. 60-927 each B.

The New Stone Arch Bridge of 295 feet Span at Plauen, Saxony. Illustrations with general description. 900 w. Eng News—Jan. 28, 1904. No. 60564.

Drawbridge.

Twin Lift-Bridge Operated by Gas Engines; New Draw Over Newark Bay, Central R. R. Co. of New Jersey. Illustrates and describes a drawbridge of unusual design erected under difficult conditions. 1600 w. Eng News—Feb. 25, 1904. No. 61081.

Girders.

The Continuous Girder Upon Elastic Supports (Der Durchgehender Träger auf Elastisch Senkbare Stützen). L. Vianello. A graphical examination of a difficult problem in statics, with applications to practical examples. Two articles, 5000 w. Zeitschr d Ver Deutscher Ing—Jan. 23, 30, 1904. No. 60919 each D.

Two Large Plate Girder Railway Bridges. Describes and illustrates two plate girder railway bridges of span exceeding 100 feet. 2500 w. Eng News—Feb. 18, 1904. No. 61043.

Highway Bridge.

Stone Highway Bridge Over the Connecticut River at Hartford. Drawings and information concerning a new bridge 1,185 feet long and 80 feet wide between parapets, with a 100-foot Scherzer rolling lift double-draw span over the canal which is on the west bank of the river, and eight semi-elliptical granite-faced arches. 1500 w. R R Gaz—Feb. 19, 1904. No. 61033.

Metal Bridges.

Rules for the Design of Metal Bridges on the Prussian State Railways. From *Zentralblatt der Bauverwaltung*. Methods of construction, calculation of strength and weights, bending moments and shearing stresses, &c. 4000 w. Bul Int Ry Cong—Jan., 1904. No. 60644 E.

Removal.

Moving a Paris Footbridge Over the Seine and Withdrawing Its Piers by Hydraulic Jacks. Rene Bonnin. An illustrated account of the methods used in moving the Passy Footbridge. 2000 w. Eng News—Feb. 18, 1904. No. 61041.

St. Petersburg.

The Troïtsky Bridge Over the Neva at St. Petersburg (Le Pont Troïtsky sur la Neva à Saint-Pétersbourg). P. Bodin. Detailed illustrated description. The construction is mixed cantilever and hinged arch, with a swing span at one end. 2500 w. 1 plate. Génie Civil—Jan. 23, 1904. No. 60902 D.

Viaduct.

The Des Moines River Viaduct of the Chicago Great Western Railway. The present number gives an illustrated description of the substructure, towers and truss spans. 2400 w. Eng Rec—Jan. 30, 1904. Serial. 1st part. No. 60551.

The Herkimer Viaduct for the Utica and Mohawk Valley Railway. Wilbur J. Watson. An illustrated description of this structure and its construction. 3000 w. Eng Rec—Feb. 27, 1904. No. 61088.

WATERWAYS AND HARBORS.

Breakwaters.

The Breakwater at Buffalo, New York. Discussion of the paper by Emile Low. 3000 w. Pro Am Soc of Civ Engrs—Jan., 1904. No. 60745 E.

Congress.

The Ninth International Navigation Congress (IX. Congrès International de Navigation). Additional reports of the French delegates. 50000 w. 14 plates. Ann des Ponts et Chaussées—2 Trimestre, 1903. No. 60938 E + F.

Dredging.

A Desirable Method of Dredging Channels Through River Bars. Continued discussion of a paper by S. Maximoff on this subject. 5500 w. Pro Am Soc of Civ Engrs—Jan., 1904. No. 60744 E.

The Dredging Fleet of Montreal Harbor. H. A. Bayfield. A discussion of such points in the operation of a dredging fleet as are of interest to dredging men. 4900 w. Can Soc of Civ Engrs—Jan. 14, 1904. No. 60725 D.

Floods.

Floods and Flood Protection Works at East St. Louis, Ill. James F. Parr. Abstract of a paper read before the Illinois Soc. of Engrs. & Survs. Relates to the experience of East St. Louis during the flood in June, 1903. 3300 w. Eng News—Feb. 4, 1904. No. 60680.

The Kansas River Flood. Charles Alma Byers. Remarks on the changes made in the river channel. 2000 w. Sci Am Sup—Feb. 13, 1904. No. 60800.

Inland Navigation.

From Sea Coast to Lakes. C. A. McAllister. An interesting account of an all-water trip from New York to Milwaukee, Wis. Illustrated. 4500 w. Marine Engng—Feb., 1904. No. 60649 C.

Mississippi.

Making the Southwest Pass of the Missippi a Ship Channel. An account of a great engineering undertaking now under way, for which Congress has appropriated $1,750,000. 2500 w. Sci Am Sup—Feb. 20, 1904. No. 61055.

Panama Canal.

The Republic of Panama. Wm. H. Burr. An illustrated article describing the country, customs, climate and conditions, and discussing the various projects for a ship canal. 6400 w. Nat Geog Mag—Feb., 1904. No. 60726 C.

Rhine.

A Hydrologic Study of the German Rhine (Etude Hydrologique du Rhin Allemand). Ed. Maillet. An examination of the work of the special commission having in charge the flood-warning system of the Rhine within the German Empire. 5000

w. Ann des Ponts et Chaussées—2 Trimestre, 1903. No. 60940 E + F.

River Beds.

The Form of Beds of Navigable Rivers (La Forme du Lit des Rivières Navigables). M. Fargue. A study of the manner in which the empirical laws are found to be verified in actual instances. 5000 w. Ann des Ponts et Chaussées—2 Trimestre, 1903. No. 60939 E + F.

River Regulation

The Cache River Drainage Survey. A. H. Bell. Abstract of a paper presented to the Illinois Soc. of Engrs. and Survs. An account of the work and the condition of the river. 1200 w. Eng News—Feb. 4, 1904. No. 60678.

The Vicksburg Harbor and the Yazoo River Diversion Canal. Walter H. Polk. An illustrated description of interesting engineering work which has given new life to the city of Vicksburg. 3000 w. Eng Rec—Feb. 20, 1904. No. 61025.

Tide Gates.

Automatic Tide Gates for the Bolsa Chica Gun Club, California. Jas. D. Schuyler. Illustrates details of construction. 600 w. Eng News—Feb. 4, 1904. No. 60677.

CONSTRUCTION.

Air-Lock.

Special Pneumatic Lock for the Harlem River Tunnel. Illustrated description. 600 w. Eng Rec—Feb. 27, 1904. No. 61093.

Bins.

Grain Pressures in Deep Bins. J. A. Jamieson. Outlines tests, calculations and discussions on this subject previously published, and presents information gained by conducting a systematic series of tests, calculations and investigations and deductions drawn. Also shows cause of certain failures, and describes a number of designs of grain bin construction. 11500 w. Can Soc of Civ Engrs—Adv Proof—Feb., 1904. No. 60724 D.

Concrete.

See Civil Engineering, Materials.

Fire Proofing.

An Account of the Baltimore Fire, with Some General Deductions. H. D. Bush. 1700 w. Eng Rec—Feb. 20, 1904. No. 61022.

Detail Studies of Fireproof Buildings in the Baltimore Conflagration. An illustrated article giving reports of various engineers who have examined the ruins. 8000 w. Eng News—Feb. 25, 1904. No. 61080.

Iroquois Theatre Fire. F. J. T. Stewart. A full report of this unfortunate disaster, with 6 plates and line illustrations. 4000 w. Ins Engng—Jan., 1904. No. 60741 C.

Steel structures in the Baltimore Fire. Gives 32 illustrations and an account of the effect of the fire upon different types of buildings, remarking on the lessons in fire-proofing taught by this disaster. 7000 w. Ir Age—Feb. 25, 1904. No. 61057.

The Baltimore Fire. An illustrated account of the fire, describing the condition of the burned buildings and giving much information of interest. Map. 7500 w. Eng Rec—Feb. 20, 1904. No. 61021.

The Recent Great Fire in Baltimore. Some facts in regard to the electrical service. 800 w. Elec Wld & Engr—Feb. 20, 1904. No. 61029.

The Record of the Fire-Proof Building in the Baltimore Conflagration. The story of this fire and the destruction wrought based upon careful study by experts. Ill. 3500 w. Eng News—Feb. 18, 1904. No. 61037.

Freezing.

Freezing as an Aid to Excavation in Unstable Material. James H. Brace. Synopsis of the result of a research of the literature on the above subject. 21000 w. Pro Am Soc of Civ Engrs—Jan., 1904. No. 60743 E.

Reinforced Concrete.

See Civil Engineering, Materials.

Roads.

The Use of Tar on Roads (Goudronnage des Chaussées). An account of the use of coal tar for laying dust on the highways in the Department of Seine-et-Marne, France. 10,000 w. Ann des Ponts et Chaussées—2 Trimestre, 1903. No. 60-941 E + F.

Roofs.

Details of the Large Timber Roof of a Public Shelter in Van Cortlandt Park, New York. Illustrates the timber roof framing and main truss of a roof covering an area of about 85 by 162 feet. 900 w. Eng Rec—Feb. 27, 1904. No. 61092.

Steel Roof Trusses in the New Union Railroad Station at Washington. Describes details of an elaborate roof, giving diagrams. 1800 w. Eng Rec—Feb. 6, 1904. No. 60664.

Tunnels.

Tunnelling Machine; Great Northern, Piccadilly and Brompton Railway. Brief illustrated description of the invention of Mr. Price. 500 w. Engng—Feb. 5, 1904 No. 60828 A.

Underpinning.

Jacking Down Open Cribs for Underpinning. Describes interesting construction work carried out in New York while erecting a steel-cage office building at the corner of Fulton and William streets. 1400 w. Eng Rec—Jan. 30, 1904. No. 60555.

MATERIALS OF CONSTRUCTION.

Cement Works.

New Cement Works at Portland, Colo. James D. Schuyler. An illustrated description of an interesting plant. 2200 w. Eng Rec—Feb. 20, 1904. Serial. 1st part. No. 61024.

The Edison Portland Cement Works. Illustrated detailed description of this remarkable plant. 1700 w. Sci Am Sup—Jan. 30, 1904. Serial. 1st part. No. 60573.

Concrete.

Concrete Hollow Wall Construction. Illustrates and describes this system of construction, claiming that it hastens drying and drainage, saves material and labor, and other advantages. 1500 w. Min & Sci Pr—Jan. 30, 1904. No. 60669.

More Light on the Theory of Concrete. Spencer B. Newberry. Read before the Indiana Engng. Soc. Discusses materials, proportions, &c. 1800 w. Eng Rec—Feb. 6, 1904. No. 60665.

Lead.

Lead Architecture. J. Starkie Gardner. An illustrated article reviewing the uses made of lead from the earliest history of the metal. Especially describes lead architecture in the past, and some suggestions for its use in the present. General discussion. 10000 w. Jour Ry Inst of British Archts—Jan. 23, 1904. No. 60871 B.

Reinforced Concrete.

A Plea for a Committee on Steel-Concrete. Ross Francis Tucker. Showing the need of rules and regulations for the guidance of engineers using this material. 1200 w. Eng Rec—Feb. 6, 1904. No. 60666.

The Kelly & Jones Company's Concrete-Steel Factory Building. An illustrated description of the Ransome system of construction; some of the details are of special interest. 1600 w. Eng Rec—Feb. 6, 1904. Serial. 1st part. No. 60663.

The Siegwart Ferro-Concrete Floor Beams. Illustrates and describes this type of floor construction. The beams are made in the factory. Reports tests made. 1200 w. Engng—Jan. 29, 1904. No. 60712 A.

See Civil Engineering, Bridges.

MEASUREMENT.

Approximations.

Inaccuracy in Some Engineering Approximations; Formulas for Elevation of Outer Rail on Curves. W. D. Taylor. Calls attention to cases of approximation where inaccuracies occur. 900 w. Eng News—Feb. 18, 1904. No. 61040.

MUNICIPAL.

Havana.

The Sanitation and Proposed Sewerage System of Havana, Cuba. A. E. Carter. Describes the conditions found when the U. S. army entered in 1898, and what has since been accomplished. The water supply and sewerage systems. 2500 w. Sch of Mines Qr—Nov., 1903. No. 60835 D.

Incinerator.

Rubbish Incineration in New York City and the Design for the New Stanton Street Incinerator. Illustrated description of the new plant, with information of interest. 4000 w. Eng Rec—Jan. 30, 1904. No. 60553.

Pavements.

Concrete Foundation and Cement Filler for Brick Pavement. O. L. Gearheart. Read before the Illinois Soc. of Civ. Engrs and Survs. Discusses the economic relations between concrete foundations of different compositions and cement filler. 1800 w. Eng Rec—Feb. 13, 1904. No. 60781.

Maintenance of Asphalt Pavements in Washington, D. C. Capt. H. C. Newcomer. An explanation of methods used for this work, the prices, etc. 1200 w. Eng News—Feb. 18, 1904. No. 61042.

The Bitulithic Pavement. W. A. Hoyt. From a paper before the Michigan Engng. Soc. Observations and conclusions gathered in superintending the construction of this pavement. 3800 w. Munic Engng—Feb., 1904. No. 60750 C.

Sewage Disposal.

Filters versus Contact Beds in Sewage Purification. W. S. Shields. From a paper before the Indiana Engng. Soc. Considers the septic tank as used in England and America, and the opinions concerning it, and describes filtration plants of interest, especially sand filters, operated intermittently and automatically. Ill. 3000 w. Munic Engng—Feb., 1904. No. 60749 C.

Sewerage and Sewage Disposal at Bedford, Ind. G. C. Houston. From a paper before the Indiana Engng. Soc. Describes the system adopted for a hilly surface, and the treatment given the sewage. 2000 w. Munic Engng—Feb., 1904. No. 60748 C.

Sewers.

The Wear of Sewer Inverts. E. A. Hermann. Explains the cause of the wear and the effect on various types and materials, the information being based largely on the sewers of St. Louis. Ill. 1500 w. Eng. News—Feb. 4, 1904. No. 60681.

WATER SUPPLY.

Austria.

Description and History of the Water Works and the American System of Filtration at Trieste, Austria. E. A. Gieseler. Map and illustrations. 2000 w. Eng Rec—Feb. 20, 1904. No. 61019.

City Supplies.

Some City Water-Supplies. E. H. S.

Bailey and Edward Bartow. Considers the supply of the Neosho River System for the cities of Chanute, Oswego and Chelopa, giving analysis and conclusions. 2500 w. Bul Univ of Kansas—Vol. II., No. 7, Nov., 1903. No. 60753 D.

Filtration.

A Rapid Filter Plant for the New Chester Water Company. Illustrates and describes a plant having a capacity of 4,000,000 gallons per day. 2200 w. Eng Rec—Feb. 27, 1904. No. 61090.

Hot Water.

Supplying Hot Water to an Office Building. A brief description of how the water is heated and supplied. 1000 w. Met Work—Feb. 13, 1904. No. 60757.

Irrigation.

Windmill Irrigation in Kansas. Philip Eastman. An illustrated article describing the transformation wrought by windmill irrigation. 1800 w. Rev of Revs—Feb., 1904. No. 60529 C.

Ozone.

See Electrical Engineering, Electro-Chemistry.

Santa Barbara.

The Proposed Tunnel for Water Development for Santa Barbara, Cal. A statement of the conditions at this place, and the means proposed for assuring an adequate water supply. 800 w. Eng News—Feb. 18, 1904. No. 61038.

South Dakota.

Notes on the Water Supplies in the Black Hills of South Dakota and Vicinity. Ellen H. Richards. Remarks on the importance of securing uncontaminated supplies for mining camps, with information concerning peculiarities of the region named. 1000 w. Tech Qr—Dec., 1903. No. 60747 E.

Typhoid.

Special Reports on Typhoid Fever and Water Supply. Statements from city officials in Philadelphia, Lowell, Mass., and Waterloo, Iowa, and in Western Pennsylvania. 3700 w. Eng News—Feb. 11, 1904. No. 60790.

The Typhoid Fever Epidemic at Columbus, O. Prof. F. H. Eno. A statement of the conditions leading up to and at present pertaining to the epidemic of typhoid fever now prevailing, with editorial comment. Map. 7200 w. Eng News—Feb. 11, 1904. No. 60791.

Typhoid Fever History and the Water Supply of Pittsburg, Allegheny and Vicinity. Prepared from data and comments thereon obtained from various health officials, giving information of the water supply systems. 6000 w. Eng News—Feb. 25, 1904. No. 61083.

ELECTRICAL ENGINEERING

COMMUNICATION.

Cables.

The Manufacture of Multiple-Core Telephone Cables with Air Insulation (Die Fabrikation Mehradiger Telephon-kabel mit Luftisolation). J. Schmiett. Describing methods of manufacture employed by several German firms. 2500 w. Zeitschr f Elektrotechnik—Jan. 17, 1904. No. 60968 D.

Cable Steamer.

See Marine and Naval Engineering.

Exchange.

The New Trunk Exchange of the Post-Office Telephone Service. Begins a detailed description of an exchange which provides telephonic communication between London and provincial and Continental towns. 900 w. Elec Rev, Lond—Feb. 5, 1904. Serial. 1st part. No. 60815 A.

Microphone.

Improvements to Maintain a Uniform Action of the Micropohone in Telephony (Neuerung zum Erreichen einer Dauernd Zuverlässigen Wirkungsweise des Mikrophons im Fernsprechbetrieb). H. Stosberg. Showing the proper proportioning of the resistances to insure permanency of action. 800 w. Elektrotech Zeitschr—Feb. 4, 1904. No. 60963 B.

Space Telegraphy.

On the Wave Length of Free Vibrations in Antennæ and Closed Oscillating Circuits. Dr. James E. Ives. Describes experimental investigations on the wave length of antennæ and of closed circuits. Deals with the change in wave length produced by inserting turns of a wire helix. 1000 w. Elec Wld & Engr—Feb. 6, 1904. No. 60688.

The Work of a Wireless Telegraph Man. Winthrop Packard. An illustrated article explaining how messages are sent and received at sea, and how wind and weather affect transmission. 2000 w. World's Work—Feb., 1904. No. 60581 C.

Wireless Telegraphy. R. G. Blaine. The introduction gives a review of the history of wireless telegraphy, to be followed by a study of the various systems. 3200 w. Elec Engr, Lond—Jan. 29, 1904. Serial. 1st part. No. 60706 A.

Telegraphy.

Efficiency of the Railway Telegraph Department. J. C. Browne. Discusses maintenance and operation, interruptions and their causes, and means of improving the service. General discussion. 5500 w. St. Louis Railway Club—Jan. 8, 1904. No. 60736.

Telephony.

The Tone Test. A. Dallam O'Brien. Describes the principle and operation of the tone test as used in connection with calls completed over long-distance and toll lines. 2200 w. Am Electn—Feb., 1904. No. 60595.

DISTRIBUTION.

Factories.

Electrical Transmission of Power as an Aid to Greater Economy in Works and Factories. George Harland Bowden. Read before the Bradford Textile Assn. Discusses engineering detail in connection with the application of electric power to mills and factories. 3800 w. Elec Engr, Lond—Jan. 29, 1904. No. 60705 A.

Frequencv Changers.

The Frequency Changers at Montreal. B. A. Behrend. Illustrates and discribes this plant and gives report of its power and efficiency. 1200 w. Elec Wld & Engr —Feb. 13, 1904. No. 60838.

Grounding.

Grounding of Constant Potential Systems. S. Bingham Hood. Illustrates the object of grounding a system and the requirements for safe operation, discussing conditions. 4200 w. Elec Wld & Engr—Feb. 20, 1904. No. 61026.

Rectifiers.

Rectifiers. Charles F. Burgess. Read at Milwaukee meeting of the Northwestern Elec. Assn. Briefly considers mechanical, vapor and electrolytic rectifiers and their efficiency. 2500 w. Elec Rev, N. Y.—Feb. 27, 1904. No. 61097.

The Electrolytic Rectifier and Interrupter. W. B. Churcher. Read before the Northwestern Elec. Assn. Describes the construction and mode of operation of these two inventions. 1500 w. Elec, N. Y.—Feb. 17, 1904. No. 60873.

Shipyards.

The Distribution of Electricity in Shipyards and Engine Works. J. A. Anderson. Read before the Newcastle Sec. of the Inst. of Elec. Engrs. A description of the different means of applying electricity and some results obtained. 3000 w. Elec Engr, Lond—Feb. 12, 1904. No. 60886 A.

Trouble.

The Location of Trouble. George T. Hanchett. The article is confined to a discussion of the location of trouble in lines. 2300 w. Cent Sta—Feb., 1904. No. 60857.

ELECTRO-CHEMISTRY.

Batteries.

The Jungner Alkaline Battery. Claims that this battery antedates the Edison battery in several important particulars. Compares the two types. 1800 w. Auto Jour—Feb. 6, 1904. No. 60808 A.

The Transformation of Thermo-Chemical Energy into Voltaic Energy or Electromotive Force Dr. D. Tommasi. An account of investigations made by the writer with discussion of the results. 1200 w. Elec Rec, Lond—Jan. 22, 1904. No. 60612 A.

Commercial Products.

Electrochemical Industries. F. B. Crocker and M. Arendt. Considers electrolytic chemistry, electro-thermal chemistry, and chemical action due to electrical discharges. 6000 w. Sch of Mines Qr—Nov., 1903. No. 60832 D.

Electro-Metallurgical Works at La Praz. Illustrates and describes this interesting industrial concern near Grenoble, France, and the work carried on there. 800 w. Electro-Chem & Met—Jan., 1904. No. 60766 E.

Copper Wire.

Electrolytic Methods for the Production of Copper Wire. An illustrated article describing the various processes that different workers in this field have tried, although they have not proved commercially successful. 1200 w. Electro-Chem & Met—Jan., 1904. No. 60765 E.

Electro-Analysis.

Recent Electro-Analytic Methods (Neue Elektronalytische Behelfe). Dr. Heinrich Paweck. Describing especially the action of rotary electrodes and their uses in electrolytic work. 2000 w. Elektrochemische Zeitschr—Feb., 1904. No. 60-974 G.

Some Applications of the Theory of Electrolysis to the Separation of Metals from One Another. A. Hollard. Read before the Faraday Soc. Presents applications of the theory of electrolysis permitting of effectual analytical separations. 3500 w. Elec Rev, N Y—Feb. 27, 1904. No. 61099.

Gold.

Electrometallurgy of Gold in South Africa—1897 to 1899. Abstracts of papers bearing on this subject, aiming to give a review of the practice in South Africa. Also editorial. 13300 w. Elec-Chem Ind —Feb., 1904. No. 60651 C.

Ozone.

Recent Progress in the Ozone Industry (Les Progrès Récents Réalisés dan l'Industrie de l'Ozone). Marius Otto. A very full account of methods of generating ozone and of its application for sterilizing processes. 8000 w. 2 plates. Mem Soc

Ing Civ de France—Nov., 1903. No. 60-935 G.

Recent Progress.

Modern Discoveries in Chemistry. Dr. J. Ohly. Some notes on recent achievements in electro-chemistry made by Julius Walther, a young Russian. 2200 w. Min Rept—Jan. 28, 1904. No. 60539.

Review.

Electro-Metallurgy in 1903. A résumé of the year's progress, giving details of the industrial applications of the Vautin and Goldschmidt process for obtaining high temperatures, and of the electric steel processes. 2300 w. Engr, Lond—Jan. 29, 1904. Serial. 1st part. No. 60719 A.

Progress in Electro-Chemistry and Electro-Metallurgy in 1903. John B. C. Kershaw. A résumé of the progress giving details of processes and manufactures. 1300 w. Elec Rev, Lond—Feb. 5, 1904. Serial. 1st part. No. 60816 A.

Separation.

Some Applications of the Theory of Electrolysis to the Separation of Metals from One Another. A. Hollard. A study of applications of the theory of electrolysis under the following headings: I. Reduction of the resistance of the bath by suppressing the formation of gas at the anodes; II. Influence of the nature of the kathode; III. Formation of complex salts. Ill. 3300 w. Electro-Chem & Met—Jan., 1904. No. 60764 E.

ELECTRO-PHYSICS.

Coil Windings.

Coil Windings for Electrical Purposes. Richard Varley and Charles R. Underhill. Read before the Northwestern Elec. Assn. A study of electromagnets and economy in winding. 3000 w. Elec Rev, N. Y.—Feb. 13, 1904. No. 60847.

Holtz Machines.

A Few Experiments with Holtz Machines. Samuel Sheldon. Abridged report presented to the Am. Electrotherapeutic Assn. A report of experimental trials, and what they appear to have established. 2300 w. Elec Rev, N. Y.—Feb. 13, 1904. No. 60845.

Insulation.

Bitumen in Insulating Compositions. Discussion of a paper by D. A. Sutherland on this subject. 2000 w. Electro-Chem & Met—Jan., 1904. No. 60763 E.

Magnet Windings.

Predetermining Magnet Windings. George W. Malcolm. An explanation of the method used by the writer. 1200 w. Am. Elect'n—Feb., 1904. No. 60594.

Radio-Activity.

A Résumé of Recent Progress in the Study of Radium and Radio-Activity. Information from recent articles in the technical press. 1800 w. Sci Am Sup—Feb. 20, 1904. No. 61054.

On the Properties of a Radioactive Gas Found in the Soil and Water Near New Haven. H. A. Bumstead and L. P. Wheeler. A report of investigations of these natural radio-active gases, concluding that they are apparently identical with the emanations from radium. 3600 w. Am Jour of Sci—Feb., 1904. No. 60527 D.

Radium. Prof. R. A. Milliken. Lecture at the convention of the Northwestern Electrical Assn. Reviews the earlier discoveries that led to the study of radioactive substances, and so to the discovery of radium, explaining its properties, etc. 1400 w. Elec, N. Y.—Feb. 3, 1904. Serial. 1st part. No. 60622.

Radium and Radioactivity (Le Radium et la Radioactivite). André Debierne. A description of the process of preparing radium from the ore, and an account of the phenomena which it displays. Two articles. 10000 w. Rev Gen des Sciences—Jan. 15, 30, 1904. No. 60911 each D.

Researches Relating to Radium. Frederick Soddy. Considers features of radium which need further inquiry,—especially the atomic weight. 2500 w. Nature—Jan. 28, 1904. No. 60694 A.

The Preparation and Properties of Radium (Le Radium. Preparation et Proprietes). Jacques Danne. An illustrated account, describing very fully the methods of detecting the presence of radium in minerals, and the complete chemical process of extraction. 3 articles. 7000 w. Génie Civil—Jan. 16, 23, 30, 1904. No. 60900 each D.

GENERATING STATIONS.

Alternators.

Applications of the Circle Diagram to Alternators (Anwendung des Kreisdiagramme auf Wechselstromgeneratoren). J. Puluj. Showing the general applicability of the diagram, originally designed by Heyland for the induction motor, to alternating-current dynamos. Two articles. 6000 w. Zeitschr f Elektrotechnik—Jan. 31, Feb. 7, 1904. No. 60971 each D.

The Excitation of Alternators. F. H. Davies. A discussion of methods of excitation. 3000 w. Elec Engr, Lond—Jan. 27, 1904. No. 60707 A.

Argentina.

The Power Plant of the Anglo-Argentina Tramway Company at Buenos Aires (Versuchs und Betriebsergebnisse an der Maschinenlage der Compania de Tramways Anglo-Argentina, Ltd., in Buenos Aires). Ad. Frei. A general description with load diagrams and indicator cards. 1800 w. Zeitschr d Ver Deutscher Ing—Jan. 30, 1904. No. 60922 D.

Armatures.

Some Practical Points in Armature Construction, Dealing Chiefly with Insulation. Hints of interest to those engaged in this class of work. Ill. 1800 w. Elec Engr, Lond—Jan. 22, 1904. No. 60611 A.

Cologne.

The Development of the Electric Stations of Cologne (Die Entwickelung der Cölner Elektricitätswerke). H. Overmann. Discussing especially the prices charged for current under the operation of a double-tariff system for different parts of the day. 5000 w. Elektrotech Zeitschr—Jan. 21, 1904. No. 60957 B.

Eddy Currents.

Eddy Currents in Dynamo Machines. Michael B. Field. A discussion of Dr. Thornton's paper on this subject. 3800 w. Elect'n, Lond—Feb. 5, 1904. No. 60818 A.

Losses Due to Eddy Currents (Ueber Wirbelstromverluste). Dr. F. Niethammer. Discussing especially pole constructions intended to reduce eddy-current losses to a minimum. 2000 w. Zeitschr f Elektrotechnik—Jan. 24, 1904. No. 60969 D.

Enlargement.

New Installation at City of South Norwalk Electric Works. An illustrated description of the third enlargement within five years of this very successful municipal plant. 2200 w. Elec Wld & Engr—Feb. 20, 1904. No. 61028.

Fort Wayne.

The New Fort Wayne Electric Works. An illustrated description of the extensive improvements made to increase the capacity and facilities. 4000 w. Engr, U S A —Feb. 1, 1904. No. 60562 C.

Generating Sets.

Turbo-Dynamo Generating Sets (Turbodynamos). Dr. F. Niethammer. Discussing especially the construction of dynamos for high rotative speeds, adapted for direct-connection with steam turbines. Serial. Part I. 1800 w. Zeitschr f Elektrotechnik—Feb. 7, 1904. No. 60972 D.

Hydro-Electric.

High-Tension Hydroelectric Plants in Roumania and Switzerland. Frank C. Perkins. Illustrates and describes interesting features of some of these plants. 1600 w. Elec Rev, N Y—Feb. 27, 1904. No. 61098.

Power Development of the Toronto & Niagara Power Company. Illustrates and describes the general features and construction methods of this engineering work. 3700 w. Eng Rec—Feb. 13, 1904. No. 60778.

The Utilization of Hydro-Electric Power in Agricultural Work (Utilisation de l'Energie Hydro-Electrique dans les Installations Agricoles). A review of the circular of the Minister of Agriculture, calling attention to the advantages of electrical distribution of hydraulic power. 1500 w. Génie Civil—Jan. 30, 1904. No. 60904 D.

Location.

Application of Graphics to Power House Location. Sidney Diamant. Describes an ingenious graphical method of locating the electrical centroid of an area, where the position and intensity of the loads is known. 800 w. Elec Wld & Engr—Feb. 13, 1904. No. 60839.

Poles.

Auxiliary Poles for Continuous-Current Dynamos (Hilfspole für Gleichstrommaschinen). Franklin Punga. Showing that auxiliary poles and commutating fields are useful only in machines operating at high rotative speeds. 1800 w. Zeitschr f Elektrotechnik—Jan. 24, 1904. No. 60970 D.

Power Curves.

The Theoretical Determination of Power Curves. William J. Berry. A mathematical demonstration. 700 w. Elec Wld & Engr—Jan. 30, 1904. No. 60592.

LIGHTING.

Arc Lamps.

The Maximum Illuminating Power of Continuous-Current Arc Lamps in a Single Direction (Ueber das Relative Maximum Einseitiger Lichtausbente bei Gleichstrom-Bogenlampen). E. Richter. With diagrams showing the variation in light emitted for different angles of inclination of the carbons. 2000 w. Elektrotechnik Zeitschr—Feb. 4, 1904. No. 60962 B.

Incandescent Lamps.

Defects in Incandescent Lamps. E. Leavenworth Elliott. Gives a copy of a defect sheet of one of the large factories, all of which are supposed to be corrected before the lamp leaves the factory, and discusses defects that develop after use. 1300 w. Cent Sta—Feb., 1904. No. 60858.

The Incandescent Lamp. Brief review of the history of its development. 900 w. Elec Rev, N Y—Feb. 20, 1904. No. 61014.

Osmium.

The Efficiency and Color of Osmium Lamps. Prof. F. G. Baily. Gives results of a recent examination of these lamps, invented by Herr Auer von Welsbach. 900 w. Elect'n, Lond—Feb. 12, 1904. No. 60890 A.

The Osmium Lamp (Ueber die Osmiumlampe). L. Lombardi. Data and results of measurements of the temperature of the filament of the osmium incandescent lamp, and its relation to illuminating efficiency. 3000 w. Elektrotech Zeitschr—Jan. 21, 1904. No. 60954 B.

Photometry.

The Photometry of Arc-Lamps. Paul F. Gaehr. Discusses the advantages of the arc-lamp photometer designed by Prof. C. P. Matthews. 1200 w. Sib Jour of Engng—Jan., 1904. No. 60738 C.

Single-Phase.

A Single-Phase Lighting-System in St. Louis. L. A. De Blois. An explanation of this system of the Missouri Edison Electric Co., and the conditions it is required to meet. 4500 w. Harvard Engng Jour—Jan., 1904. No. 60740 D.

Theatre Lighting.

The Electric Lighting of Drury Lane Theatre Royal. An illustrated review of the electric lighting arrangements, describing in detail recent improvements. 3300 w. Elect'n, Lond—Feb. 12, 1904. No. 60889 A.

MEASUREMENT.

Ampere Meter.

Multiple Ampere Meter (Vielstufige Strommesser). K. Feussner. Illustrating a convenient form of instrument, with seven resistances, rendering it available for various applications; the method of calibrating is described. 4000 w. Elektrotech Zeitschr—Feb. 11, 1904. No. 60966 B.

Capacity.

The Numerical Determination of the Capacity of Aerial Conductors and Cables (Ueber die Rechnerische Bestimmung der Kapacität von Luftleitern und Kabeln). Leo Lichtenstein. Giving formulas and diagrams and showing their applications to practical examples. Serial, Part I. 5000 w. Elektrotech Zeitschr—Feb. 11, 1904. No. 60965 B.

Magnetic Tests.

Magnetic Tests of Whole Sheets of Iron. Illustrates and describes apparatus on which whole sheets can be tested without any waste of material. 1000 w. Engng—Jan. 29, 1904. No. 60711 A.

Resonance.

The Precision and Operation of the Hartmann & Braun Resonance Instruments (Ueber Genauigkeit und Wirkungsweise der Hartmann & Braunschen Resonanzinstrumente). Dr. R. Hartmann-Kempf. Illustrating and describing instruments for measuring frequency and phase relations. 3000 w. Elektrotech Zeitschr—Jan. 21, 1904. No. 60956 B.

Rheostats.

Liquid Rheostats (Ueber Flüssigkeitsanlasser). Dr. F. Niethammer. Discussing the effects of various arrangements of electrodes, and different kinds of electrolytes. 2000 w. Zeit f Elektrotechnik—Jan. 17, 1904. No. 60967 D.

Wattmeters.

Effects of the Wave-Forms on Measurements by the Two-Wattmeter Method. Abstract translation of article by Dr. L. Bloch, in *Elektrotech. Zeitschrift.* A discussion of the methods of measuring the effects of polyphase currents. 1200 w. Elec Engr, Lond—Feb. 12, 1904. No. 60885 A.

MOTORS.

Cascade System.

Cascade Operation of Motors for Rolling Mills (Kaskadenschaltungen bei Motoren für Walzwerke). E. Danielson. An account of the performance of induction motors operating rolling mill machinery at Näs, Delelfven, Sweden. A hydrostatic station of 2700 h. p. is included. 2000 w. Elektrotech Zeitschr—Jan. 21, 1904. No. 60955 B.

Efficiency.

Determination of the Efficiency of a Galatti Asynchronous Motor (Determinazione di Rendiments di un Motore Asincrono Galatti). G. Sartori. Applying the Heyland circle diagram. 1200 w. L'Elettricita—Jan. 8, 1904. No. 60973 B.

Electric Power.

Providing the World with Power. Arthur Goodrich. On the great increase in the use of electricity, the factories where electrical devices are made, etc. 4500 w. World's Work—Feb., 1904. No. 60579 C.

Induction Motors.

On Asynchronous Motors. N. Pensabene. An explanation of a method more convenient than the Heyland diagram. Mathematical. 1100 w. Elec Engr, Lond—Feb. 12, 1904. No. 60887 A.

On the Magnetic Dispersion in Induction Motors, and Its Influence on the Design of These Machines. Dr. Hans Behn-Eschenburg. A description of theoretical and experimental researches communicated to the Institution of Electrical Engineers through Prof. S. P. Thompson. 2800 w. Elect'n, Lond—Jan. 22, 1904. Serial. 1st part. No. 60613 A.

Magnetic Brake.

Magnetic Brake for Small Electric Motors. Illustrates and describes two types devised by Siemens & Halske, explaining the principle of their action. 900 w. Sci Am—Feb. 20, 1904. No. 61051.

Mine Power.

See Mining and Metallurgy, Mining.

Motor Diagram.

The Circle Diagram of the Induction Motor (Das Kreisdiagramm des Mehrphasenmotors). A. Heyland. A communication regarding the question of priority of use of the diagram, with some examples of its application. 1800 w. Elektrotech Zeitschr—Jan. 21, 1904. No. 60958 B.

Pendulum Systems.

Electrical Foucault Pendulum Systems. Ernest K. Adams. Considers various electromagnetic pendulums, and suggests ingenious electric expedients for maintaining the amplitude of vibration. Ill. 5200 w. Elec Wld & Engr—Jan. 30, 1904. No. 60591.

Printing Office.

Mechanical and Electrical Equipment of the Sackett & Wilhelms Lithographing and Printing Company. An illustrated description of the building and plant, which shows many unique features. 2000 w. Elec Rev, N Y—Feb. 6, 1904. Serial. 1st part. No. 60661.

Repulsion Motor.

On the Circle-Diagram of the Repulsion Motor. F. Creedy. Containing a general method of deducing the graphic theory of any alternating current apparatus. 1200 w. Elec Rev, Lond—Feb. 5, 1904. Serial. 1st part. No. 60813 A.

Series Motor.

The Alternating-Current Series Motor. F. D. Newbury. A detailed explanation of its operation. 2000 w. Elec Rev, N Y—Feb. 6, 1904. No. 60660.

Single-Phase Motor.

British Lamme Single-Phase Railway Motor Patent. Reprint of the full specification of the British patent granted to B. G. Lamme, with drawings. 5000 w. Elec Wld & Engr—Feb. 13, 1904. No. 60840.

Discussion on A. I. E. E. Papers on the Single-Phase Railway Motor. Discussion in full by Messrs. Lamme, Steinmetz and Armstrong, and the non-mathematical part of the remarks of Prof. A. S. McAllister. 8000 w. Elec Wld & Engr—Feb. 13, 1904. No. 60841.

The Regulation of Single Phase Commutator Motors (Einphasenkollektormotoren und ihre Regelung). Friedrich Eichberg. A mathematical discussion, with numerous diagrams referring especially to the motor designed by the author and Herr Winter. 5000 w. Elektrotech Zeitschr—Jan. 28, 1904. No. 60960 B.

TRANSMISSION.

High-Voltage.

European Practice in the Construction and Operation of High-Pressure Transmission Lines and Insulators. Guido Semenza. Illustrated descriptions of iron poles, insulators, etc. 4500 w. Trans Am Inst of Elec Engrs—Feb. 26, 1904. No. 61062 D.

The Conductivity of the Atmosphere at High Voltages. Prof. Harris J. Ryan. Paper before the American Inst. of Elect. Engrs., giving an analysis of the factors that produce the energy losses through the atmosphere on high-voltage lines, with account of laboratory experiments and diagrams. 8800 w. Trans Am Inst of Elec Engrs—Feb. 26, 1904. No. 61061 D.

Leakage.

The Measurement of Distributed Leakage on Transmission Lines. Frank F. Fowle. Describes methods of measuring insulation resistance. Mathematical. 2000 w. Elec Wld & Engr—Feb. 6, 1904. No. 60689.

Long Distance.

The American River Electric Company's Plant on the South Fork of the American River. Illustrates and describes a model plant recently completed in Central California. Power is transmitted to Stockton, eighty miles, and to Folsom, thirty miles further. 3300 w. Jour of Elec—Feb., 1904. No. 60836 C.

Transformers.

Ordinary Transformer Connections. William H. Kritzer. Explanations with diagrams. 700 w. Min & Sci Pr.—Feb. 6, 1904. No. 60867.

MISCELLANY.

Electric Inventions.

The Relation of Electric Inventions to Human Activity. Dr. Louis Bell. A review of the fundamental electrical inventions, including the telegraph, telephone, dynamo, motor, incandescent lamp, etc., showing their nature as labor-saving appliances. 3000 w. Engineering Magazine—March, 1904. No. 60993.

Germany.

A Study of the Electrical Industry in Germany (Etude sur l'Industrie Electrique Allemande). L. Sekutowicz. A full review of the development of the industry of electrical machinery and the operation of plants, with a discussion of recent business reorganizations. 10,000 w. Mem Soc Ing Civ de France—Dec., 1903. No. 60937G.

GAS WORKS ENGINEERING

Acetylene.

Dissolved Acetylene and Its Applications (L'Acétylène Dissous et ses Principales Applications). F. Bourdil. Describing the Fouché modification of the method of Claude and Hess for dissolving acetylene in acetone and rendering it safe for transportation. Applications to train lighting, blowpipe, etc., are given. 2000 w. Mem Soc Ing Civ de France—Nov., 1903. No. 60934 G.

Specifications for an Acetylene Gas Generating Apparatus for Fort McPherson, Ga. Gives specifications in full, omitting the "General Conditions." 1800 w. Eng News—Feb. 4, 1904. No. 60675.

Ammonia.

A Few Notes on Ammonia. F. E. Sheriff. Read before the Michigan Gas Assn. Considers the recovery from the gases obtained by the carbonization of bituminous coal. 2000 w. Am Gas Lgt Jour—Feb. 22, 1904. No. 61008.

Benches.

Care of Benches and Results Therefrom. T. J. Whalen. Read at meeting of Michigan Gas Assn. Considers causes of poor results and some of the troubles in retort houses. 5500 w. Am Gas Lgt Jour —Feb. 22, 1904. No. 61007.

Gas Producer.

The Deschamps Down Draft Gas Producer. Translation from an article in the *Bulletin de la Société de l'Industrie Minerale,* by Jules Deschamps, concerning an invention for the purpose of producing a gas of the most suitable composition for use in gas engines. Ill. 2500 w. Ir Age—Feb. 4, 1904. No. 60603.

Retorts.

Inclined Retorts at Chesterfield. An illustrated description of a new installation, with brief account of these works. 3000 w. Gas Wld—Feb. 13, 1904. No. 60883 A.

Small Works.

The Construction and Operation of Small Gas-Works in Germany. Dr. E. Schilling. From a lecture delivered before the Bavarian Union of Gas and Water Engrs., at Munich. Gives information regarding the cost of various kinds of plants, and the progress in the consumption of illuminating gas. 3800 w. Pro Age—Feb. 1, 1904. No. 60533.

Water Gas.

The Kramer and Aarts Water-Gas Process. Dr. Alph. Steger. Read before the German Gas Assn. Summary. Describes methods of making blue water gas. Claims efficiency under test of 85 per cent. Discussion. Ill. 3300 w. Gas Wld—Jan. 30, 1904. No. 60704 A.

The Principal Applications of Water Gas (Le Gaz à l'Eau et ses Principales Applications). E. Demenge. With especial reference to the Dellwik-Fleischer process, and to the industrial uses of water gas, such as heating, welding, etc. 4000 w. Rev Gen des Sciences—Jan. 30, 1904. No. 60913 D.

Water Gas. Prof. A. Humboldt Sexton. Describes various plants and their method of working. Ill. 4500 w. Mech Engr—Feb. 13, 1904. Serial. 1st part. No. 60-875 A.

INDUSTRIAL ECONOMY

Cost Keeping.

A Card Index System for Obtaining the Cost and Distribution of the Non-Productive Labor. George P. Pearce. An explanation of a system of the writer's, which is for all practical purposes, accurate. 2300 w. Am Mach—Feb. 11, 1904. No. 60776.

See also Mechanical Engineering, Machine Works and Foundries.

Education.

Nautical Education in Japan. Facts of interest from the prospectus of the Nautical College at Tokio, showing the provision made for the scientific training of officers and men. 1500 w. Nature—Feb. 4, 1904. No. 60801 A.

Oxford and Science. Dr. John Perry. An address discussing the neglect of scientific training at the English universities, and its importance upon the international position of the country in political and commercial matters. 7500 w. Nature—Dec. 31, 1903. No. 60995 D.

Technical Education in Germany. Max Wurl. An explanation of the educational system in the German empire, followed by discussion. 10800 w. Trans N E Coast Inst of Engrs & Shipbldrs—Jan., 1904. No. 60755 D.

Technical Instruction in Germany. W. G. Rhodes. Discusses German methods, comparing them with English instruction. Confined to courses in electrical engineering. 1800 w. Elec Rev, Lond—Feb. 12, 1904. No. 60888 A.

Technical Education in the United States (Der Technische Schulunterricht in den Vereinigten Staaten). P. Kreuzpointner. A review of the curricula and methods of American technical schools by a German engineer resident in the United States. 6000 w. Zeitschr d Ver Deutscher Ing—Jan. 23, 1904. No. 60918 D.

The Mathematical Training of Engineers. R. Howard Duncan. A discussion of the training needed by a professional engineer, considering the usual training given in mathematics and how it may be improved. 2000 w. Prac Engr—Jan. 29, 1904. Serial. 1st part. No. 60703 A.

Transatlantic Engineering Schools and Engineering. R. Mullineux Walmsley. On the educational methods and training adopted in the United States, as viewed during a recent trip of inspection, and a discussion of applications to Great Britain. 18300 w. Inst of Elec Engrs—Feb. 11, 1904. No. 60884 D.

What Inducements to Enter "Light Current Engineering" Are Held Out to Technical Students. Joseph B. Baker. Explains what is meant by "light current engineering," and discusses the fields of telephony, telegraphy, and wireless telegraphy. 1600 w. Elec Rev, N Y—Feb. 13, 1904. No. 60844.

Invention.

"Invention." Editorial review of an address by J. Fletcher Moulton as President of the Junior Inst. of Engrs. 2000 w. Engng—Jan. 29, 1904. No. 60715 A.

Presidential Address before the Junior Institution of Engineers. J. Fletcher Moulton. Abstract of a valuable address on invention, the equipment of the inventor, the aims, etc. 6000 w. Engr, Lond—Jan. 29, 1904. No. 60721 A.

Relation of Employer and Employee in Reference to Inventions. Grafton L. McGill. Read before the Modern Science Club of Brooklyn, N. Y. Discusses various classes of relations between employer and employee and the doctrines tending to the general welfare. 2800 w. Am Mach—Feb. 4, 1904. No. 60639.

Labor.

Reconciling the Conflict Between Employers and Employees. Ralph M. Easley. Discusses the questions lying back of industrial disturbances, and the outlook. 4400 w. Bankers' Mag, N Y—Feb., 1904. No. 60727 C.

The Denaby Main Case. Summary of facts and decision, with editorial, in this case where employers have successfully held the Union responsible for damages during an illegal strike. 5000 w. Engr, Lond—Feb. 12, 1904. No. 61000 A.

Trade Unions and Employers' Associations. Charles W. Eliot. From an address to the Boston Central Labor Union. A review of the principles which govern the relations between employers and employees, and of the past history and present methods. 4500 w. R R Gaz—Feb. 12, 1904. No. 60796.

Labor-Saving.

The World's Great Labor Savers and Labor Servers. Robert W. Hunt. A review of the work which has been done by the great inventors and engineers of the past century, with numerous portraits. 3500 w. Engineering Magazine—March, 1904. No. 60986 B.

Machinery.

The Effects of Labor-Saving Machinery. Frank H. Rose. A conservative view of the effect of machinery upon the wage earner, showing the result to be beneficial to employer and employee. 4000 w. Engineering Magazine—March, 1904. No. 60987 B.

Metallurgical Industries.

The Decline of Metallurgical Enterprise in England. Henry F. Collins. A review of the causes that explain the decline of all metallurgical industries with the exception of iron and steel. 2800 w. Eng & Min Jour—Feb. 4, 1904. No. 60653.

Patents.

Patents Which Obstruct. George W. Dickie. Read before the Tech. Soc. of the Pacific Coast, (Condensed). A discussion of patents and the kind of patent business that is objectionable, giving illustrations of cases. 4500 w. Am Mach—Feb. 4, 1904. No. 60638.

Premium Plan.

A German View of the Premium Plan. B. Schiller. Abstract of a paper published in the *Zeitschrift des Vereines Deutscher Ingenieure.* A critical examination of the advantages and disadvantages of the various modifications of the Halsey premium plan of rewarding labor. 2500 w. Am Mach—Feb. 18, 1904. Serial. 1st part. No. 60850.

Syndicates.

The German Coal Cartel and Its Renewal. Francis Walker. The plan of organization and the results accomplished by the coal and coke syndicates. 7500 w. Mines & Min—Feb., 1904. Serial. 1st part. No. 60627 C.

MARINE AND NAVAL ENGINEERING

Breakdown.

The Accident on H. M. S. "Bullfinch." Gives the evidence relating to the dimensions of the jaw of the connecting-rod which fractured and caused the disaster, and the magnitude of the forces producing the stress under which the fracture took place. Ills. 2500 w. Engng—Feb. 5, 1904. No. 60825 A.

British Shipping.

Free Trade and British Shipping. W. H. Renwick. Discusses the restrictions imposed by Parliament, and compares with foreign competition; considers subsidies and other matters affecting the shipping interests. 6000 w. Nineteenth Cent—Feb., 1904. No. 60870 D.

Cable Steamer.

The Cable-Laying Steamer Stephan (Le Stephan, Navire Poseur de Cables). Illustrated description of the new vessel of the German cable company, used for laying the second line via the Azores to New York. 1500 w. 1 plate. Génie Civil—Jan. 30, 1904. No. 60903 D.

Coaling Plant.

Frenchman's Bay Coaling Plant. Illustrated description of this naval coal depot on the Maine coast. 3700 w. Eng Rec—Jan. 30, 1904. No. 60552.

Cruisers.

The Japanese Cruisers "Kasuga" and "Nisshin." Illustrated description of the two cruisers purchased from the Argentine Government by Japan. 600 w. Engng—Jan. 22, 1904. No. 60616 A.

The Military Capabilities of Cruisers (La Guerra di Crociera). Romeo Bernotti. An examination of the strength and weakness of high-speed cruisers in modern naval warfare. 10000 w. Rivista Marittima—Jan., 1904. No. 60948 H.

Ferryboat.

New Screw Ferryboat. Illustration with details of the boat which is to be used in the immigration transfer service at the port of New York. 1000 w. Naut Gaz—Feb. 4, 1904. No. 60659.

Fishing Steamer.

Norwegian Fishing Steamer. Illustrations and description of the latest type of smaller 75-foot fishing steamers used on the north and west coasts of Norway. 1200 w. Marine Engng—Feb., 1904. No. 60646 C.

Fleets.

The Japanese and Russian Fleets. Reviews the naval strength of the two countries. 1800 w. Engr, Lond—Feb. 12, 1904. No. 61001 A.

The War Fleets of Japan and Russia. Archibald S. Hurd. An illustrated review giving much information of interest. 8400 w. Cassier's Mag—Feb., 1904. No. 61067 B.

Floating Dock.

The New Off-Shore Floating Dock for the Reiherstieg Schiffswerfte und Maschinenfabrik, Hamburg. Two-page plate with description. 1200 w. Engng—Feb. 12, 1904. No. 60895 A.

Ice-Breakers.

Ice-Breakers and Their Services. Arthur Gulston. Deals with vessels that work among ice that is formed from year to year, illustrating and describing types. Discussion. 9000 w. Jour Soc of Arts—Jan. 29, 1904. No. 60696 A.

Launching.

Launching an Armored Cruiser. Data in connection with the launch of the first-class armored cruiser Roxburgh. 900 w. Engng—Jan. 29, 1904. No. 60716 A.

Motor Boats.

First National Motor Boat Show. Illustrations and descriptive notes on the gasoline launches and engines displayed at Herald Square Exhibition Hall, New York. 2000 w. Automobile—Feb. 20, 1904. No. 61050.

Naval Station.

The New Admiralty Works at Dover. Illustrated description of a future British naval station. 800 w. Page's Mag—Feb., 1904. No. 61073 B.

Navy.

The Japanese Navy. A review of this modern navy, with many illustrations. 3300 w. Sci Am—Feb. 13, 1904. No. 60799.

The Russian Navy. Gives the leading particulars of Russia's battleships, so far as known, illustrating many of them. 2700 w. Sci Am—Feb. 20, 1904. No. 61052.

Neutral Vessels.

Neutral Vessels in War Time. Editorial discussion of some of the principles of international law which apply for the protection of neutral vessels. 2200 w. Engng—Jan. 22, 1904. No. 60617 A.

Propellers.

An Inquiry Regarding the Marine Propeller. J. Millen Adam. An endeavor to concentrate the attention on the propeller and the fluid which passes through it, as a conservative system in the sense indicated by an illustration from the art of rope-making. Ills. 5400 w. Trans Inst of Engrs & Shipbldrs in Scotland—Vol. 47, Part III. No. 60732 D.

Marine Propellers with Non-Reversible Engines and Internal Combustion Engines. Discussion of Mr. Rankin Kennedy's paper on this subject. Ill. 4300 w. Trans Inst of Engrs & Shipbldrs in Scotland—Vol. 47, Part III. No. 60731 D.

Schooners.

American Coasting Schooners. Illustration, plans and details of the Dorothy Palmer, one of the latest and best of the wooden types. 1700 w. Naut Gaz—Feb. 18, 1904. No. 60899.

Speed.

On the Extreme Cost of High Speed. Sidney Graves Koon. Discusses the cost of power for the required speed in the case of steamships. 1300 w. Sib Jour of Engng—Jan., 1904. No. 60739 C.

The Influence of Depth of Immersion Upon Speed (De l'Influence de la Surimmersion sur la Vitesse). J. A. Normand. Developing formulas for computing the effect of changes in draught upon the speed of vessels. 2000 w. Comptes Rendus—Dec. 28, 1903. No. 60929 D.

Steamer.

Twin-Screw Steamer "Corona" for Northern Nigeria. Illustrated description of vessel of galvanized steel, built on the tunnel principle, for service as a yacht. 1,000 w. Engng—Jan. 29, 1904. No. 60714 A.

Torpedoes.

Attack and Defense of Coasts by Means of Torpedoes (Attaque et Défense des Côtes au Moyen des Torpilles). H. Noalhat. The first installment of a serial dealing with design and construction of automobile torpedoes. Serial. Part I. 3500 w. Revue Technique—Jan. 10, 1904. No. 60908 D.

Vibration.

The Torsional Vibration of Screw Propeller Shafts (Vibrazioni Torsionali degli Alberi delle Macchine Marine). Pietro Enrico Brunelli. An examination of the influence of the torsion of the shaft of a marine engine upon the period of vibration of the machinery. 4000 w. 1 plate. Rivista Marittima—Jan., 1904. No. 60949 H.

Wrecks.

Drouillard's Drifter Balloon Float. Describes an ingenious apparatus used to carry a rope between a vessel in distress and the land. 800 w. U S Cons Repts—Feb., 1904. No. 60722 D.

Yachts.

The Laying Up and Storing of Small Yachts for Winter. Frederic S. Nock. Explains methods of hauling out of the water, stripping the rigging, and other points necessary to properly protect the vessel. 1500 w. Marine Engng—Feb., 1904. No. 60648 C.

MECHANICAL ENGINEERING

AUTOMOBILES.

Achilles.

The 1904 Achilles Petrol Cars. Illustrates and describes these cars, built in English works, and intended for "men of moderate means." 2000 w. Auto Jour—Feb. 13, 1904. No. 60878 A.

Carburettor.

The Automatic Carburettor on the Crossley Car. Illustrated description. 1500 w. Auto Jour—Feb. 13, 1904. No. 60880 A.

Chenard-Walcker.

The 18 H. P. Chenard and Walcker Car. Illustrated description of the interesting features. 1400 w. Autocar—Jan. 23, 1904. No. 60604 A.

The 1904 Chenard and Walcker Petrol Cars. An illustrated detailed description of these vehicles. 3000 w. Auto Jour—Jan. 23, 1904. No. 60606 A.

Chicago Exhibits.

Some Novel Western Cars Exhibited. Illustrates and describes interesting cars shown at Chicago. 3000 w. Automobile—Feb. 13, 1904. No. 60772.

Closed Cars.

Closed Automobile Bodies—Their Development and Present Styles. Illustrations and brief descriptions of interesting types. 2000 w. Automobile—Feb. 13, 1904. No. 60773.

Crossley.

Some Further Details of the Crossley Petrol Car. Illustrations with description of features of interest. 1800 w. Auto Jour—Feb. 6, 1904. No. 60807 A.

The "Crossley" Petrol Motor-Car. Illustrates and describes a car which aims to be second to none in quietness and steadiness of running, durability and reliability. 2200 w. Motor-Car Jour—Jan. 30, 1904. No. 60695 A.

Daimler.

The Daimler Motor Company. An illustrated account of the work of this company in automobile construction, describing the methods. 4700 w. Trac & Trans—Feb., 1904. No. 60819 E.

Exhibitions.

Automobilism at the Salon of December, 1903 (L'Automobilisme au Salon de Décembre 1903). Gérard Lavergne. A brief review of the recent exhibition in Paris, showing broadly the progress there displayed. 2000 w. Rev Gen des Sciences—Jan. 15, 1904. No. 60912 D.

Interesting and Novel Features of Car Construction at the Madison Square Show. H. L. Towle. Remarks on features of interest observed at the recent exhibition in New York. 2000 w. Automobile—Jan. 30, 1904. No. 60534.

Show Hints for Intending Buyers. Rene M. Petard. Begins an illustrated discussion of the vital parts of car construction. 2400 w. Automobile—Jan. 30, 1904. No. 60535.

Show Tendencies in Construction. Hugh Dolnar. A brief discussion of the recent exhibition in New York and the types predominating. 1700 w. Automobile—Jan. 30, 1904. No. 60536.

Society of Motor Manufacturers' Exhibition at the Crystal Palace. Illustrated descriptions of interesting exhibits. 3500 w. Auto Jour—Feb. 13, 1904. No. 60881 A.

Fire Engine.

Automobile Fire Engine (Pompe à Incendie Automobile). F. Drouin. An illustrated account of the Weyher & Richemond automobile steam fire engine as shown at the recent exhibition in Paris. 1800 w. 1 plate. Génie Civil—Feb. 6, 1904. No. 60905 D.

Germain.

The Germain Standard Car. Illustrated detailed description. 1000 w. Autocar—Jan. 30, 1904. No. 60709 A.

The 1904 Germain Petrol Cars. An illustrated description of a 16-h. p. vehicle made by these Belgium manufacturers. 2500 w. Auto Jour—Feb. 13, 1904. No. 60877 A.

Legislation.

The Motor Car Act and Regulations. W. Valentine Ball. Deals with the provisions of the English Motor Car Act, 1903, and the regulations made under it, with a view to showing in what respects the law has been modified. 5000 w. Trac & Trans —Feb., 1904. No. 60820 E.

Mieusset.

The Mieusset Petrol Cars. Illustrated description of cars built in Lyons, France. 2500 w. Auto Jour—Feb. 6, 1904. No. 60806 A.

Oldsmobile.

The 1904 Oldsmobile. Illustrates and describes this car, which is simple in construction, easily managed and quiet running. 1200 w. Autocar—Feb. 6, 1904. No. 60809 A.

Pedrail.

Recent Developments of the Pedrail. Gives reasons why it is believed this system will come into general use, and explains the principles on which its construction is based. Ill. 3000 w. Auto Jour—Jan. 23, 1904. Serial. 1st part. No. 60607 A.

Pope-Toledo.

The 24 Horse-Power Pope-Toledo Touring Car. Illustrated detailed description of the 1904 model gasoline touring car. 1200 w. Sci Am—Jan. 30, 1904. No. 60570.

Railway Vehicles.

See Railway Engineering, Motive Power and Equipment.

Review.

The Progress of Automobilism in 1903 (Les Progrès de l'Automobilisme en 1903). F. Drouin. A review of improvements in details of construction during the year, chiefly shown in the exhibitions. 3 articles. 6,000 w. Génie Civil—Jan. 16, 23, 30, 1904. No. 60901 each D.

Richard.

Georges Richard-Brazier Cars. Illustrates and describes a popular type of car made in four powers, of almost identical design. 1000 w. Autocar—Feb. 13, 1904. No. 60876 A.

Road Train.

A New System of Continuously Propelled Road Trains (Sur un Nouveau Système de Train Routier Dit à Propulsion Continue). Ch. Renard. An account of the Renard system of automobile road trains, showing especially the method of steering. 1200 w. Comptes Rendus—Dec. 28, 1903. No. 60930 D.

Ryknield.

The Ryknield Cars. Illustrates and describes some of the leading features of these cars. 800 w. Autocar—Feb. 6, 1904. No. 60811 A.

Siddeley.

The Siddeley Petrol Cars. Brief illustrated description of the latest design built for this company. 800 w. Auto Jour—Feb. 13, 1904. No. 60882 A.

Steam Cars.

Steam Cars for Public Service. Thomas Clarkson. Presents the necessity for superseding horse traction by mechanical means and discusses the principles of construction in such vehicles and the claims of the steam car. General discussion. 7400 w. Jour Soc of Arts—Feb. 5, 1904. No. 60802 A.

Steering.

Steering Gears: Their Principles and Action. A critical discussion of the "single pivot" or "fifth wheel" type, showing that it is not suitable for motor vehicles. 1200 w. Autocar—Jan. 23, 1904. No. 60605 A.

Thomas.

The Thomas Triple-Cylinder Touring Car. Illustrated detailed description. 2000 w. Sci Am—Jan. 30, 1904. No. 60571.

Upkeep.

The Cost, Care and Upkeep of a Motor Car. A paper by Dr. Gilpin, read before the Lincolnshire Auto. Club. 2000 w. Autocar—Feb. 6, 1904. No. 60810 A.

Western Cars.

Features of New Western Cars. Calls attention to new and interesting features as shown in the cars at the Chicago exhibition. 4000 w. Automobile—Feb. 20, 1904. No. 61049.

See also Mechanical Engineering, Internal-Combustion Motors.

HEATING AND COOLING.

Absorption Process.

Recent Absorption Refrigerating Machines (Nouvelles Machines Frigorifiques à Affinité). J. Hignette. Describing the Larrieu & Bernat machine, recently installed at Grenelle, Paris. 2000 w. Mem Soc Ing Civ de France—Dec., 1903. No. 60936 G.

Central Plants.

Central Station Heating. W. H. Schott. Read before the Northwestern Elec. Assn. Discusses things necessary if heating from central stations is to prove successful and profitable. 3200 w. Elec Rev, N Y—Feb. 13, 1904. No. 60846.

Foundations.

Foundations for Ice Machines. T. R. Wingrove. First of a series of articles on erecting and operating refrigerating machines; discusses preparing for and building suitable foundations. 2400 w. Ice & Refrig—Feb., 1904. Serial. 1st part. No 60654 C.

Hot-Water.

Description of the Hot-Water Heating Apparatus in the Schioldann Institution, Copenhagen, Denmark. A. B. Reck. Read at N. Y. meeting of the Am. Soc. of Heat. & Ven. Engrs. Explains the climate and conditions in Denmark and describes the method of heating employed. Short discussion. 5500 w. Met Work—Jan. 30, 1904. No. 60524.

Public Schools.

Warming and Ventilating of Public Schools. From a paper by D. M. Nesbit, read before the Com. on Hygiene, San. Inst. Cong., Bradford, Eng. Suggestions for small, medium sized and large schools. 1200 w. Dom Engng—Jan. 25, 1904. No. 60538 C.

Radiation.

Radiation or Pipe Surface Required for Greenhouses and for Ordinary Buildings Having Considerable Variations in Construction, Size and Temperature. Walter Jones. Read at London meeting of the Inst. of Heat. & Ven. Engrs. Condensed paper containing technical information. 1400 w. Dom Engng—Jan. 25, 1904. No. 60537 C.

Steam Heating.

Steam Heating from a Central Station. F. B. Hofft. Read before the Indiana Engng. Soc. Particularly describing the plant of the Merchants' Heat and Light Company of Indianapolis, and its operation. Considers the system nearly ideal. 2000 w. Munic Engng—Feb., 1904. No. 60751 C.

Vacuum Process.

Ice Making by the Vacuum Process. Edward A. Osse. Illustrated description of machinery and process used. 1200 w. Ice & Refrig—Feb., 1904. No. 60655 C.

HYDRAULICS.

Connecticut.

A New Water Power Development at New Milford, Connecticut. Walter Scott Morton. Begins an interesting illustrated account of the development of the Bull's Bridge plant. 2300 w. Eng Rec—Feb. 13, 1904. Serial. 1st part. No. 60780.

High-Pressure Power on the Housatonic. Illustrates and describes the Bull's Bridge power plant on the Housatonic River, which differs from usual eastern practice. 3300 w. Elec Wld & Engr—Feb. 13, 1904. No. 60837.

Hydraulic Machinery.

Hydraulic Power Appliances in Engineering Industries. George H. Baxter. Especially discussing hydraulic transmission, cranes, hoisting machinery, dock and harbor appliances. Serial. Part I. 5000 w. Engineering Magazine—March, 1904. No. 60990 B.

Water Power.

A Low-Head Mill Power at Juliette, Ga. Plan and description of the water-power development. 1500 w. Eng Rec.—Feb. 6, 1904. No. 60667.

Wharf Installation.

Hydraulic Crane at the Tower Wharf of the General Steam Navigation Company. Illustrations and brief description of an installation consisting of seven hydraulic jib-cranes. 800 w. Engng—Feb. 12, 1904. No. 60896 A.

MACHINE WORKS AND FOUNDRIES.

Can Making.

Niagara Automatic Can Body Machine. Illustrated description of an invention of Edmund Zeb which promises an output of 30,000 cans a day. 2500 w. Ir Age—Feb. 18, 1904. No. 60859.

Chains.

The Evolution of the Chain. J. Hartley Wicksteed. Traces its history from the earliest times, discussing its modern developments. Fully illustrated. 6000 w. Page's Mag—Feb., 1904. No. 61072 B.

Cost Keeping.

See Industrial Economy.

Crane.

A Special Form of Electric Travelling Crane (Elektrisch Betriebener Spezial-laufkran). A. Dondelinger. Illustrating a travelling ladle crane made for the Chatillon-Commentry works in connection with its basic steel plant. 2000 w. Stahl u Eisen —Jan. 1, 1904. No. 60978 D.

Crank Pins.

Capitaine's Crank-Pin Turning Machine. Illustrations with brief description. 600 w. Engng—Feb. 12, 1904. No 60894 A.

Crucibles.

Crucible Furnaces for Foundry Work (Tiegelöfen im Giessereibetriebe). C. Inesberger. Showing recent forms of crucible furnaces for making brass, bronze, gray-iron and steel castings. Serial. Part I. 3000 w. Stahl u Eisen—Feb. 1, 1904. No. 60984. D

Cupolas.

Notes on Cupolas and Cast Iron. C. Morehead. Read before the Rugby Engng. Soc. Discusses things bearing on the melting and mixing of iron, temperatures, blast pressures, etc. 4500 w. Prac Engr—Jan. 29, 1904. No. 60701 A.

Dies.

Forging-Machine Dies. Thomas Beasley. Illustrates and describes the making of a number of dies. 1200 w. Am Mach—Feb. 18, 1904. No. 60851.

The Making of a Sub-Die and Punch. F. B. Burnham Describes a method which the writer has proved successful. 1200 w. Ir Trd Rev—Feb. 4, 1904. No. 60658.

Drawing Office.

The Group Drawing Office System. Walter Ferris. Describes this system as used by the Bucyrus Company. 3400 w. Am Mach—Jan. 28, 1904. No. 60548.

Forging Press.

An Austrian Steam-Hydraulic Forging Press. Illustrates and describes a 1200-ton forging press which consists of a steam-hydraulic intensifier and press proper. 600 w. Sci Am Sup—Jan. 30, 1904. No. 60575.

Foundry.

A Modern Jobbing Foundry. An illustrated detailed description of the plant of the Buffalo Foundry Co. 2200 w. Foundry —Feb., 1904. No. 60530.

Foundry Costs.

Foundry Costs: Their Analysis and Reduction. Henry Hess. Outlines a successfully used method of cost analysis. Discussion. 4000 w. Pro Engrs' Club of Phila —Jan., 1904. No. 60760 D.

Foundry Machinery.

Labor Saving Machinery in Foundry Operations. Dr. R. Moldenke. A fully illustrated account of the latest improvements in cranes, ladles, moulding machines, conveyors, core machines, and other appliances. 3500 w. Engineering Magazine—March, 1904. No. 60991 B.

Gear Blanks.

Machinery Gear Blanks in the Lathe. Frank B. Kleinhans. An illustrated description of a lathe fitted with a turret drilling attachment and its use. 600 w. Am. Mach—Jan. 28, 1904. No. 60550.

Grinder.

An Electric Grinder. F. C. Mason. Illustrated description of an electric grinding machine, designed and built by the writer, which has given satisfaction. 1000 w. Am Mach—Feb. 18, 1904. No. 60853.

Hardening.

Hardening Machine Tool Parts. John Randal. Illustrates and describes the methods used in the Sloan & Chace shops, Newark, N. J. 1000 w. Am Mach—Feb. 25, 1904. No. 61077.

Individual Driving.

Motor-Driven Machine Tools. Explains the conditions to be considered when arranging for a planing machine drive. Ill. 2200 w. Am Engr & R R Jour—Feb., 1904. No. 60590 C.

The Individual Application of Electric Motors to Machinery, with Rules for Determining the Size of Motors. William Cooper. Calls attention to points of importance if these motors are to give satisfaction, illustrating by cases, and gives rules for determining sizes. 3500 w. Cassier's Mag—Feb., 1904. No. 61071 B.

Jigs.

Jig for Drilling and Milling. C. T. Sutton. Illustrated description of a jig adapted to any ordinary high-speed lathe at slight cost. 900 w. Engr, Lond—Feb. 12, 1904. No. 61006 A.

Lathes.

Special Lathe for Recessing Small Shafts. H. Robinson. Line drawings with brief description. 350 w. Am Mach—Feb. 11, 1904. No. 60777.

The Putnam 90-Inch Driving Wheel Lathe. Illustrated description of one of the most powerful locomotive driving wheel lathes ever built. 1700 w. Ir Age—Feb. 11, 1904. No. 60692.

Lifts.

Factory Schemes—Three Special Lifts. S. A. Worcester. Illustrates and describes three lifts designed for special work. 1200 w. Am Mach—Feb. 18, 1904. No. 60852.

Link Motion.

Who Really Invented the Link Motion. W. L. Campbell. Presents facts in proof of the claim that Williams, and not Howe, invented the link motion. 4000 w. Am Mach—Feb. 11, 1904. No. 60775.

Machine Driving.

Electric Power in Tanneries. George E. Walsh. An illustrated description of what has been accomplished in utilizing electricity for the operation of tanneries. 1700 w. Elec Rev, N Y—Feb. 20, 1904. No. 61016.

Modern Methods of Operating Machine Tools Electrically. General text of a lecture by Putnam A. Bates before the

Engng. Soc. of Columbia Univ. Considers the methods of electric distribution and the arrangements of the motors. 2500 w. Elec Wld & Engr—Feb. 13, 1904. No. 60842.

The Electric Driving of Machinery in Shops of the Austrian State Railways at Linz (Der Elektrische Betrieb in den k. k. Staatsbahn-Werkstätten Linz.) R. Dub and E. Suchy. With plan of the shops and details of the generating station, cranes and machinery. 3000 w. Elektrotech Zeitschr—Feb. 4, 1904. No. 60961 B.

Machine Tools.

Machine Tools. Gives extracts from a paper by James K. Cullen, presented to the Western Ry. Club, with editorial notes. 3000 w. Loc Engng—Feb., 1904. No. 60582 C.

Moulding.

Making Complicated Pieces in Moulding Machines (Herstellung Komplizierter Gegenstande auf Formmaschinen). F. Wüst. Giving examples of moulding flanged pulleys, bevel gears, etc., by machinery. 1200 w. Stahl u Eisen—Feb. 1, 1904. No. 60985 D.

Piano Factory.

A Modern Piano-Forte Factory. Illustrates and describes the plant of John Broadwood and Sons, Limited, at Old Ford. 1200 w. Engr, Lond—Feb. 12, 1904. No. 61004 A.

The Electrical Plant at the Broadwood Grand Piano-Forte Factory at Old Ford. Illustrated detailed description. 2800 w. Elec Engr, Lond—Feb. 5, 1904. No. 60812 A.

Portable Machines.

Portable Electric Drilling and Riveting Machines. Frank C. Perkins. Illustrations of various types with descriptions. 1600 w. Cassier's Mag—Feb., 1904. No. 61068 B.

Riveted Joints.

Efficiencies of Riveted Joints. Gilbert S. Walker. Gives a diagram for determining the efficiency, explaining the method of using it. 2000 w. Eng News—Feb. 4, 1904. No. 60679.

Shafting Lathe.

Shaft Turning Machine. H. Robinson. An illustrated description of a new semi-automatic double-head turning machine. 600 w. Am Mach—Jan. 28, 1904. No. 60547.

Shop Equipment.

Factory Schemes—Overhead Trolley Systems and Dipping Apparatus. S. A. Worcester. Outline drawings and description of these appliances and their operation. 1200 w. Am Mach—Feb. 11, 1904. No. 60774.

Shops.

Shop No. 3 of the Bullock Electric Mfg. Company. Illustrated detailed description. 1800 w. Mach, N Y—Feb., 1904. No. 60559 C.

The New Henry R. Worthington Hydraulic Works at Harrison, N. J. The present article gives an illustrated description of foundations, power plant, transportation and machine erecting shops. 5000 w. Eng Rec—Feb. 6, 1904. Serial. 1st part. No. 60662.

Shop System.

Two Card Systems for the Shop. H. C. Hammack. Explains a card index method of keeping employees' records, and outlines a "follow up" system for manufacturers and jobbers. 2500 w. Ir Trd Rev—Feb. 4, 1904. No. 60657.

Shrink Fits.

Removing Shrink Fits—Freeing a Set Idler. D. S. Cole. Illustrations with description of methods used by the writer. 2500 w. Am Mach—Feb. 4, 1904. No. 60635.

Special Tools.

Special Machine Tools at the Corliss Shops. Illustrates and describes designs of two decades ago made by Mr. Corliss for economical production of his engines. 4300 w. Ir Age—Feb. 4, 1904. No. 60601.

Tube Making.

The Manufacture of Charcoal Iron Railway Boiler Tubes. George G. Crawford. An illustrated description of the various processes from the charcoal pig iron to the finished tube. Discussion. 2500 w. Pro W Ry Club—Jan. 19, 1904. No. 60803 C.

The Manufacture of Welded Pipe. Victor Beutner. Reviews the history of tube manufacture, the material used, the design of pipe mills, the pipe welding furnace, and the bending furnace in the present number. Ill. 4300 w. Ir Age—Feb. 4, 1904. Serial. 1st part. No. 60602.

Wheels.

The Manufacture of Chilled Iron Wheels. Illustrated description of the work as carried out at the Edinburgh works of Messrs. Miller & Co. 2000 w. Tram & Ry Wld—Feb. 11, 1904. No. 61075 B.

Wire Netting.

Making Wire Netting. An illustrated description of interesting wire-working devices embodied in a machine invented by Charles W. James. 1000 w. Am Mach—Feb. 4, 1904. No. 60637.

Wood-Working.

Modern Wood-working Machinery. M. Powis Bale. A résumé of the chief and latest types in use, illustrated from recent photographs, with remarks on design, speeds, etc. 4300 w. Engng Rev—Feb., 1904. Serial. 1st part. No. 61066 B.

MATERIALS OF CONSTRUCTION.

Alloys.

Alloys of High Tensile Strength. Herbert E. Field. A reply to a correspondent who has had trouble in securing a strong composition by using Dr. R. H. Thurston's formula. 1800 w. Mach, N Y—Feb., 1904. No. 60561 C.

Preparing Alloys for Casting. Walter J. May. Some points on the making and handling of alloys. 1200 w. Prac Engr—Jan. 29, 1904. No. 60702 A.

The Segregatory and Migratory Habit of Solids in Alloys and in Steel Below the Critical Points. J. E. Stead, in *Jour. of the Soc. of Chem. Ind.* An illustrated study with conclusions reached. 6300 w. Ir & Steel Met—Feb., 1904. No. 60735 D.

Cast Iron.

Recent Investigations and Discoveries in Cast Iron. Alexander E. Outerbridge, Jr. Calls attention to hitherto unobserved properties as determined by experiments. Tabulated results, and discussion. Ill. 6800 w. Jour Fr Inst—Feb., 1904. No. 60729 D.

The Testing of Cast Iron. Dr. R. Moldenke. Read before the New England Found. Assn. Gives proposed specifications upon which cast iron may be bought and sold, discussing related matters. 3500 w. Ir Age—Feb. 18, 1904. No. 60861.

The Resistance and Structure of Cast Iron (Festigkeit und Struktur des Gusseisens). Oskar Leyde. Giving data and results of trials on test bars, showing the influence of dimensions on structure. 2500 w. 1 plate. Stahl u Eisen—Jan. 15, 1904. No. 60982 D.

Convention.

The Fifth Convention of the German Society for Testing Materials (Die Fünfte Hauptversammlung des Deutschen Verbandes für die Materialprüfungen der Technik). A general report of the proceedings of the meeting of Sept. 5, 1903, at Rübeland (Harz). 6000 w. Zeitschr d Ver Deutscher Ing—Jan. 30, 1904. No. 60923 D.

Elastic Limit.

The Elastic Limit of Metals. Discusses the Investigations of M. Frémont. Ills. 1700 w. Nature—Jan. 21, 1904. No. 60569 A.

Microstructure.

On the Microstructure of Metals and Alloys. William Campbell. An interesting illustrated paper showing the value of microscopic study of metals and treatment that causes changes. 3800 w. Elec-Chem Ind—Feb., 1904. No. 60650 C.

Nickel Steel.

The Determination of Nickel in Steel. (Dosamento del Nichelio nell' Acciaio). Luigi Zambelli. Describing a laboratory method for the quantitative determination of the percentage of nickel in a nickel-steel alloy. 1800 w. Rivista Marittima—Jan., 1904. No. 60950 H.

Paints.

The Technology of Paint and Varnish. Alvah Horton Sabin. Gives a review of the use of paints and varnishes, giving much information in regard to them. 4500 w. Cassier's Mag—Feb., 1904. No. 61069 B.

Steel Castings.

Steel Castings. C. W. Gennet, Jr. Aims to correct false impressions and to give information concerning the material and its adaptations. 2500 w. R R Gaz—Feb. 26, 1904. No. 61086.

The Widening Use of Steel Castings in the United States. W. P. Barba. Reviews some of the newer uses of steel castings. Ills. 4000 w. Cassier's Mag—Feb., 1904. No. 61070 B.

Sulphuric Acid.

On the Manufacture of Sulphuric Acid at Sydney, C. B. Presented at meeting of the Canadian Min. Inst. Gives a sketch of the process, discussing details as carried out at the Dominion & Steel Co.'s plant in Sydney, Nova Scotia. 4200 w. Can Min Rev—Jan. 31, 1904. No. 60656 B.

Testing.

See Mechanical Engineering, Measurement.

Thermit.

Thermit: Its Application to Metallurgical Engineering. C. V. Boys. Calls attention to some peculiar properties of aluminium, shared also to some extent by magnesium, and gives the history and development of thermit. General discussion. 8800 w. Jour Soc of Arts—Feb. 12, 1904. No. 60874 A.

MEASUREMENT.

Graphostatics.

Graphostatic Computations for Moving Machine Parts (Grundzüge einer Graphostatischen Berechnung Bewegter Maschinenteile). Paul Wostrowsky. With diagrams analysing the inertia forces of moving bodies; with practical applications. Two articles. 8000 w. Zeitschr d Oesterr Ing u Arch Ver—Jan. 15, 22, 1904. No. 60924 each D.

Kinemometer.

A Differential Recording Kinemometer (Sur un Cinémometre Différentiel Enregistreur). J. Richard. Illustrating and describing a recording apparatus capable of showing speed variations to the thousandth part of a second. 1200 w. Comptes Rendus—Jan. 18, 1904. No. 60932 D.

Meter.

A Steam Meter. R. S. Bayntun. Illustrates and describes an invention for measuring and recording the weight of quantity of steam passing through a pipe. 1400 w. Elec Rev, Lond—Feb. 5, 1904. No. 60814 A.

Pyrometers.

Recent Progress in High Temperature Measurement (Die Neuesten Fortschritte in der Messung Hoher Temperaturen). Dr. Ludwig Harald Schütz. A fully illustrated account of the most recent forms of pyrometers, including metallic, electric and optical varieties. 3500 w. Zeitschr d Ver Deutscher Ing—Jan. 30, 1904. No. 60921 D.

The Wanner Pyrometer. Illustrates and describes this apparatus for measuring high temperatures. 1500 w. Ir Age—Feb. 18, 1904. No. 60862.

Stresses.

Alternate Bending Stresses. Charles B. Dudley. Some remarks on the strains involved and the kind of metal best calculated to resist them. Ills. 1700 w. Ir & Steel Met—Feb., 1904. No. 60734 D.

Testing.

Testing of Iron and Steel. A. N. Kemp. Considers the usual methods of testing, describing two of the best known machines. Ills. 4000 w. Engng Times—Feb., 1904. No. 61059 B.

Testing Machine.

A Large Testing Machine. An account of the recently completed machine for the testing laboratory of Paris, adapted for testing all kinds of substances. 1200 w. Engr, Lond—Jan. 29, 1904. No. 60720 A.

The Emery Testing Apparatus at the Massachusetts Institute of Technology. Day Allen Willey. Illustrated description of experimental apparatus for testing material used in the construction of bridges, buildings, vessels, etc. 1400 w. Sci Am Sup—Jan. 30, 1904. No. 60574.

POWER AND TRANSMISSION.

Central Station.

A Central Heating, Lighting and Ice-Making Station, Gulfport, Miss. An illustrated description of a station for supplying heat, light and ice to an adjacent hotel and other buildings. 1300 w. Eng Rec—Feb. 27, 1904. No. 61089.

Compressed Air.

Air Compressors (Luftkompressoren). E. W. Koester. A review of the performance of various arrangements of steam and air cylinders with diagrams showing the distribution of work, and the flow in the passages. 5000 w. Zeitschr d Ver Deutscher Ing—Jan. 23, 1904. No. 60916 D.

A New Vacuum System for Pneumatic Transmission. Illustrates and describes the system based on the Dinspel-Stoetzel patents. 2500 w. Ir Age—Feb. 11, 1904. No. 60693.

Compound Multiple-Stage Air Compressor (Verbund - Stufenkkompressor). Julius Divis. Describing an improved Riedler compressor of 70 cubic metres per minute capacity, recently erected at Nurschau, Bohemia. 1500 w. 1 plate. Glückauf—Jan. 23, 1904. No. 60944 D.

Explosion in Compressed Air Pipes at Aberbeeg Colliery, Monmouthshire. R. Jordan. Read before the So. Wales Inst. of Engrs. An account of an explosion occurring April 9, 1902, with discussion of cause. 2700 w. Col Guard—Jan. 22, 1904. No. 60614 A.

Pneumatic Tools and Compressed Air for General Railroad Work. W. P. Pressinger. Considers some of the latest devices, particularly appliances not in general use. General discussion. 11200 w. Ry Club of Pittsburgh—Dec., 1903. No. 60758 C.

The Operation of Compressed Air Motors with Expansion (Betrieb von Druckluftmotoren mit Expansion). H. Althans. An examination of the practicable increase in efficiency of compressed-air motors for mining service. 1500 w. Glückauf—Jan. 30, 1904. No. 60946 D.

Sawing by Compressed Air. Illustrated detailed description of a pneumatic saw, known as the Redfield pneumatic engine and frame. 800 w. Compressed Air—Feb., 1904. No. 60869.

Cone-Pulleys.

A Graphic Solution of the Open-Belt Cone-Pulley Problem. Lucien E. Picolet. Presents graphical solution. 1000 w. Am. Mach—Feb. 18, 1904. No. 60854.

Conveying.

A Novel Coal Handling Plant. Illustrates and describes the hoisting plant for the Milwaukee Electric Railway and Light Company. The coal is stored at the top of the building and a special method was devised to handle it rapidly and economically. 500 w. Eng News—Feb. 25, 1904. No. 61082.

Elevators.

Electrically-Driven Hydraulic Passenger Lifts. An illustrated description of the passenger elevators installed at the Shepherd's Bush Station of the Central London railway. 1800 w. Engng—Feb. 5, 1904. No. 60827 A.

Some Notes on a Recent Elevator Accident. Charles R. Pratt. An explanation of the Frazier system which operated the elevators at 74 Broadway, New York, where an accident occurred Feb. 2, 1904. Also refers to other systems. 1600 w. Eng News—Feb. 11, 1904. No. 60789.

Exposition.

Some Details of the Louisiana Purchase Exposition Service Power Plant. Illustrates some of the more interesting details of this plant, discussing the novel features. 4000 w. Eng Rec—Feb. 27, 1904. No. 61091.

Hoist.

A Special Lift. S. A. Worcester. Illustrated description of a lift designed to be used in connection with the binder of a harvesting machine, explaining the operation. 900 w. Am. Mach—Feb. 4, 1904. No. 60634.

Shafting.

Construction of Line Shafting. H. E. Raabe. Suggestions for improving the form of shafts, showing the weakness of several designs. 1200 w. Marine Engng—Feb., 1904. No. 60647 C.

Spiral Gears.

Graphical Solutions for Spiral Gears. A. Thompson. An explanation of the graphical method used by the writer. 1000 w. Am Mach—Jan. 28, 1904. No. 60549.

Variable Speed.

An Improved Electro-Mechanical Variable-Speed Gear (Nouveaux Dispositifs Electromécaniques d'Embrayage et de Changement de Vitesse Progressifs). Paul Gasnier. A combination of an epicyclic gear train, a motor and a dynamo, the latter in connection with a rheostat, regulating the driving reaction. 1500 w. Comptes Rendus—Dec. 28, 1903. No. 60931 D.

INTERNAL-COMBUSTION MOTORS.

Carburetters.

Carburators, Vaporizers and Volatilizers Used in Petrol, Alcohol, Kerosene and Crude Oil Engines. E. Butler. Illustrates and describes various types of carburators in the present article. 2400 w. Engng Rev—Feb., 1904. Serial. 1st part. No. 61064 B.

Furnace Gas.

Blast Furnace Gas as the Sole Motive Power of a Modern Iron Works (Hochofengas als Alleinige Betriebskraftquelle eines Modernen Hüttenwerks). Karl Gruber. Showing the amount of power available in waste furnace gases, and the practicability of its use. Two articles, 7000 w. Stahl u Eisen—Jan. 1, 15, 1904. No. 60976 each D.

Gas Engines.

Engines for Use with Lean Gas (Les Moteurs à Gaz Pauvre). A. Abraham. An exhaustive examination of the thermal and mechanical conditions involved in the direct production of power from gases of low calorific value. Serial. Part I. Revue Technique—Jan. 10, 1904. No. 60910 D.

Gas Engines in Railway Work. William T. Magruder. Reviews the different classes of engines now on the market, aiming to give a general view of the entire field, and considers the purposes for which they are used in railway work, giving some results, and discussing other uses to which they may be applied. 10800 w. Pro Cent Ry Club—Jan. 8, 1904. No. 60830 C.

Gasoline Motors.

Design for a Two-Cycle Gasoline Motor. J. C. Brocksmith. Gives working drawings of a two-cylinder two-stroke-cycle air-cooled type of gasoline motor adapted to light automobile work, with descriptive notes. 2500 w. Am Elect'n—Feb., 1904. No. 60598.

Governing.

Governing Gas and Gasoline Engines. Dugald Clerk. Read before the Auto Club of Great Britain & Ireland. A review of methods used in the past and present. 3300 w. Mech Engr—Feb. 6, 1904. No. 60805 A.

Petrol Engine.

The Crossley Petrol Engine. An illustrated article describing details of construction. 2000 w. Auto Jour—Feb. 13, 1904. No. 60879 A.

STEAM ENGINEERING.

Boilers.

Boiler Material and Boiler Corrosion (Kesselmaterial und Kesselcorrosionen). H. Rinne. A discussion of the influence of boiler material upon the nature and extent of corrosion. 4000 w. Stahl u Eisen Jan. 15, 1904. No. 60981 D.

Boiler Room Practice. W. T. Edwards. A discussion of various practices and things necessary to the safe management of boilers. 2500 w. Am Elect'n—Feb., 1904. No. 60600.

Blowing Engine.

The Mackinac Blowing Engine at the Calumet and Hecla Mines. Joseph S. Soddy. Illustrates and describes a four-cylinder, triple-expansion condensing engine, rated at 7000 h. p. capacity, and to be the largest of this type in the world. 1000 w. Power—Feb., 1904. No. 60576 C.

Coal Consumption.

Coal Consumption in Central Stations. Alfred S. Giles. Slightly condensed paper read before the Manchester Soc. of the Inst. of Elec. Engrs. A study of the question of fuel economy. 3500 w. Mech Engr—Jan. 23, 1904. No. 60609 A.

Corliss Valves.

The Corliss Valve for Marine Work. Charles M. Jones. Shows the ease with which the valve may be fitted, and claims it is as near perfect against leakage as can be wished. 800 w. Am Shipbldr—Feb. 11, 1904. No. 60723.

Explosion.

A Peculiar Explosion of Water-tube

Boilers. John E. Higdon. An illustrated account of the wreck of the boiler house and boilers of the St. Louis Transit Company. 1300 w. Eng. Rec.—Feb. 13, 1904. No. 60782.

A Remarkable Boiler Explosion. An illustrated account of the explosion which occurred Dec. 21 at the Geyer Avenue Power Station of the St. Louis Transit Company. 2700 w. Power—Feb., 1904. No. 60577 C.

Feed Water.

New Type of Purifying Plant—Industrial Water Company. Illustrated description of plant built for the Houston Coal and Coke Company at Elkhorn, W. Va. 1000 w. R. R. Gaz—Feb. 12, 1904. No. 60795.

The Water Softening Plant of the Procter & Gamble Co., Ivorydale, O. Illustrates and describes a new plant having a capacity of 35,000 gallons per hour. 900 w. Eng. News—Jan. 28, 1904. No. 60565.

Firing.

Mechanical Auxiliaries to the Economy of the Fireroom. Reginald Pelham Bolton. Including coal and ash conveyors, mechanical stokers, and the detailed appliances of the modern boiler house. 4000 w. Engineering Magazine—March, 1904. No. 60992 B.

Governors.

The Development of the Shaft Governor. William O. Webber. An illustrated article briefly considering three classes of shaft governors. 1400 w. Engr, U S A—Feb. 1, 1904. No. 60563 C.

Mechanical Draft.

Mechanical Draft. J. I. Lyle. Read before the Engine Builders' Assn. Explains the advantages of forced draft, describing types. 2000 w. Engr, U S A—Feb. 15, 1904. No. 60868.

Pistons.

Pistons and Packing Rings. Amos Price. Reports ideas advanced at a recent meeting of an engineers' society when this subject was discussed. Ills. 1700 w. Am Mach—Feb. 4, 1904. No. 60636.

Prime Movers.

The Prime Mover and Its Influence on the World's Progress. John E. Sweet. Reviewing the development of the steam engine, and the effects upon civilization and material progress; with numerous illustrations. 4000 w. Engineering Magazine—March, 1904. No. 60988 B.

Steam Engines.

Portable Engine and Saw Bench. Illustrates and describes an engine and self-acting saw bench for pioneer work in forests, light enough to be easily transported. 500 w. Engr, Lond—Feb. 12, 1904. No. 61005 A.

Steam and Internal Combustion Engines Compared for Central Station Work. Norman McCarty. Gives a statement showing the itemized cost of operation of light internal combustion engine plants, of the Diesel type, comparing with the cost of operation when steam engines are used. 1800 w. Elec Rev, N Y—Jan. 30, 1904. No. 60525.

Theory of a New Method of Converting the Energy in Steam into Mechanical Work (Theoretische Betrachtung über eine Neue Art der Umsetzung von Dampfenergie in Mech. Arbeit). Eugen Dolder. A discussion of the theoretical possibility of utilizing the kinetic energy of a discharge of steam to a higher degree than heretofore. With comments by Prof. Stodola. 1200 w. Schweiz Bauzeitung—Jan. 16, 1904. No. 60928 B.

Verticle Triple-Expansion Engine (Stehende Dreifachsexpansions - Dampfmaschine). S. Iglauer. Brief illustrated account of 1000 h. p. engine forming part of generating set in the generating station at Budapest, Hungary. 1000 w. 1 plate. Zeitschr d Ver Deutscher Ing—Jan. 16, 1904. No. 60914 D.

Steam Flow.

Researches Upon the Discharge of Steam (Versuche über den Ausfluss des Wasserdampfes). M. F. Gutermuth. With tables and curves giving the discharges from various kinds of orifices based on recent experiments made at the technical high school at Darmstadt. 4000 w. Zeitschr d Ver Deutscher Ing—Jan. 16, 1904. No. 60915 D.

Steam Jacket.

The Economical Use of the Steam Jacket. A. H. Gibson. Considers under what conditions a steam jacket may or may not conduce to economy. 3000 w. Engng Rev—Feb., 1904. No. 61063 B.

Steam Turbines.

Efficiency Test of 1250 K. W. Steam Turbine for Interborough Company, New York City. A. M. Mattice. Gives important results of a series of performance tests upon a 1250 k. w. Westinghouse-Parsons steam turbine generating unit. Ill. 2500 w. Elec Wld & Engr—Feb. 20, 1904. No. 61027.

Notes on the Curtis Turbine. Reviews a portion of a paper by F. Samuelson, read before the Rugby Engng. Soc. Ill. 800 w. Elect'n, Lond—Feb. 5, 1904. No. 60817 A.

Notes on the Brown-Boveri-Parsons Steam Turbine (Mitteilungen über Dampfturbinen von Brown-Boveri-Parsons). O. Reidt. Data and results of tests upon Swiss-built Parsons turbines in various parts of Germany. 2000 w. Zeitschr d Ver Deutscher Ing—Jan. 23, 1904. No. 60917 D.

The Curtis Steam-Turbine. An illustrated description of this type and an explanation of its working. 2000 w. Engng—Feb. 5, 1904. No. 60826 A.

The Riedler-Stumpf Steam Turbine. Abstract of a paper by Dr. A. Riedler, published by the *Schiffbautechnische Gesellschaft.* An illustrated account of an important German wheel in successful use. 3000 w. Mach, N. Y.—Feb., 1904. No. 60560 C.

The Riedler-Stumpf Steam Turbines. Illustrated description of the special features, with remarks. 3000 w. Engng—Feb. 12, 1904. No. 60892 A.

The Steam Turbine. William Chilton. Abstract of a paper read before the Manchester Sec. of the Inst. of Elec. Engrs. An illustrated description of the principal types and their operation. 3300 w. Prac Engr—Feb. 12, 1904. Serial. 1st part. No. 60898 A.

The Turbine Problem. H. F. Schmidt. Considers the principles and theories underlying the construction of vapor turbines. 5000 w. Am Elect'n—Feb., 1904. No. 60597.

See Also Electrical Engineering, Generating Stations.

Superheating.

Superheated Steam. Discussion of paper by F. J. Rowan. 5000 w. Ills. Trans Inst of Engrs & Shipbldrs in Scotland—Vol. 47, Part III. No. 60730 D.

Thermal Diagrams.

Thermal Diagrams and Their Practical Use. Hugo Diemer. Gives methods for constructing thermal diagrams, which with information given by indicator cards and other data usually taken during an engine test, will disclose all heat interchanges and heat relationship. 2500 w. Bul Univ of Kansas. Vol. II., No. 6.—Nov., 1903. No. 60752 D.

Valve Gears.

Valve Gears. C. C. Major. Discusses the effect of connecting-rod angularity. 1000 w. Am Elect'n—Feb., 1904. No. 60599.

Valves.

Causes of Explosions of Cast-Iron Steam Valves (Causes d'Explosion des Valves en Fonte). S. Perissé. Discussing the importance of providing by-pass communication to avoid water-hammer shocks and consequent ruptures. 2000 w. Génie Civil—Feb. 6, 1904. No. 60906 D.

MINING AND METALLURGY

COAL AND COKE.

Calorimeters.

Comparison of Different Types of Calorimeters Extract from a paper by J. S. S. Brame and Wallace A. Cowan read before the London Sec. of the Soc. of Chem. Ind., giving a report of investigations and the results. 1700 w. Gas Wld—Jan. 23, 1904. No. 60610 A.

Coke.

The Valuation of Furnace and Foundry Coke (Die Bewertung von Hochofen und Giessereikoks). Oskar Simmersbach. A discussion of the various properties of coke which should be considered in estimating its value. 3500 w. Stahl u Eisen—Feb. 1, 1904. No. 60983 D.

Coke-Drawing.

The Hebb Coke-Drawing Machine. Illustrates and describes a device recently built for mechanically removing the coke from the coke ovens. 1300 w. Mines & Min—Feb., 1904. No. 60625 C.

Colorado.

The Walsenburg Coal District of Colorado, R. C. Hills. Abstract of monograph published by the U. S. Geol. Survey. A description of the geology, the area and the different coal seams found. Ills. 2500 w. Mines & Min.—Feb., 1904. No. 60632 C.

Dusty Mines.

The Spraying or Watering Problems of Dusty Mines. James Ashworth. Dangers connected with spraying as shown by various experiments and dust explosions. 1800 w. Mines & Min—Feb., 1904. No. 60626 C.

France.

In the French Black Country. Remarks on St. Etienne, the conditions of mining, hours of labor, wages, &c. 2800 w. Ir & Coal Trds Rev—Jan. 29, 1904. No. 60824 A.

Mining Devices.

Mechanical Devices at Coal Mines. L. L. Logan. Read before the Cent. Min. Inst. of W. Penn. Illustrates some improvements in car-dumps, mine-car running gear, and rock-dumping apparatus. 3500 w. Mines & Min—Feb., 1904. No. 60631 C.

New Zealand.

Coal Mining in New Zealand. Information from the annual report of the Minister of Mines for New Zealand, for year ending Dec. 31, 1902. 1400 w. Col Guard—Feb. 12, 1904. No. 60891 A.

Norton Coals.

The Norton Coals of the Big Sandy Basin. H. W. Althouse. An illustrated description of deposits in Virginia and Kentucky. 1400 w. Eng & Min. Jour—Feb. 11, 1904. No. 60783.

San Pedro.

Geology of the San Pedro District, San Luis Potosi, Mexico. George Irving Finlay. An account of the geological relations of the ore bodies, intended to supplement the paper of George F. Laird in which the conditions of the San Pedro mines were outlined and the development described. Ill. 3200 w. Sch of Mines Qr—Nov., 1903. No. 60834 D.

Slate-Pickers.

Mechanical Slate-Pickers. Considers appliances used in the dry method of separating the slate from anthracite coal. Ill. 2500 w. Eng & Ming Jour—Feb. 25, 1904. No. 61094.

Structure.

On the Structure of Coalfields. Thomas Parton. Read before the N. S. W. Chamber of Mines. Details on the structure of coalfields with special reference to the splitting of seams. 5000 w. N Z Mines Rec—Dec. 16, 1903. No. 60699 B.

Surveying.

Anthracite Mine Surveying Practice. Brief account summarizing the methods of several companies. 1600 w. Eng & Min Jour—Feb. 11, 1904. No. 60785.

Washington Mines.

Coal Production of Washington for 1903. C. F. Owen. Statement condensed from annual report of output. 900 w. Min. Rept—Feb. 11, 1904. No. 60856.

West Virginia.

The Henry Colliery. J. T. Jennings. Description of extensive modern developments in the coal mines of West Virginia. 3500 w. Eng & Min Jour—Feb. 18, 1904. No. 61045.

COPPER.

Consolidation.

The British Columbia-Snowshoe Consolidation. E. Jacobs. An account of the uniting of two low-grade copper mines to the mutual interest, with description of the properties. Ill. 2000 w. Eng & Min Jour—Jan. 28, 1904. No. 60558.

Ores.

Copper Ores and Their Physical Appearance. Describes the principal copper minerals with which a prospector has to deal. 1300 w. Min & Sci Pr—Jan. 23, 1904. No. 60541.

Supplies.

Copper Supplies. Editorial review of the supplies of copper to Europe during last year, and discussion of the probable production throughout the world. 2000 w. Engng—Jan. 22, 1904. No. 60618 A.

GOLD AND SILVER.

Alaska.

The Mining Prospects on Seward Peninsula. A report by the United States geologist on the placer mines in this part of Alaska. 700 w. Pacific C Min—Feb. 13, 1904. No. 60872.

British Columbia.

Quesnelle Forks Mining Division of British Columbia. W. M. Brewer. Illustrated description of a great placer mining region and the developments. 4000 w. Mines & Min—Feb., 1904. No. 60623 C.

Colorado.

Mining Problems in Colorado. Percy A. Leonard. Remarks on recent improvements in smelting and cyanide practice, and other advances in development. 1000 w. Min & Sci Pr—Jan. 30, 1904. No. 60670.

Cyanide.

A Colorimetric Method for the Determination of the Gold in Cyanide Solutions. Prof. A. Prister. Explains the chemistry and practical working of the method. 1500 w. Jour of Chem, Met & Min Soc of So. Africa—Dec., 1903. No. 61011 E.

Improvements in Cyanidation. Alfred James. Reproduction of the larger portion of a circular letter in cyanide practice. 1800 w. Eng & Min Jour—Jan. 28, 1904. No. 60557.

Notes on the Limitations of the Cyanide Process. H. T. Durant. Deals principally with ores in which gold is carried free in quartz or other gangue. 1200 w. Jour of Chem., Met & Min Soc of So Africa—Dec., 1903. No. 61010 E.

The Electric Reduction of Gold from Cyanide Solutions. A. A. Beadle. Explains the advantage of electrical reduction in the treatment of refractory ores. 1000 w. Min & Sci Pr—Jan. 30, 1904. No. 60672.

Homestake.

Discovery and Development of the Homestake Mine. Brief account of this large low-grade gold mine. 1300 w. Min & Sci Pr—Jan. 23, 1904. No. 60542.

Some Features of Mining Operations in the Homestake Mine, Lead, South Dakota. Illustrations, with description, of features of one of the largest and most productive gold mines in the world. 2000 w. Min & Sci Pr—Feb. 13, 1904. Serial. 1st part. No. 61030.

Kolar Gold-Field.

The Geology of the Kolar Gold-Field. A. Mervyn Smith. Abstract of a paper read before the Inst. of Min. & Met., London. An illustrated description. 1500 w. Eng & Min Jour—Feb. 11, 1904. No. 60784.

New Mexico.

Notes on New Goldfields, Sierra County, New Mexico. E. P. Smith. Describes a discovery on the east side of the Rio Grande, and the crude methods of treating. 800 w. Min & Sci Pr—Jan. 23, 1904. No. 60540.

New Zealand.

Notes on the Geology, Quartz Reefs and Minerals of the Waihi Goldfield. P. G. Morgan. An account of the mining geology of this field, with list and description of minerals found. 7000 w. N Z Mines Rec—Dec. 16, 1903. No. 60697 B.

The Romance of Gold-Mining. A. W. Tyndall. Prize Essay. An account of the discovery of the Blue Spur, near Lawrence, Otago. 1800 w. N Z Mines Rec—Dec. 16, 1903. Serial. 1st part. No. 60-698 B.

Slimes.

A Trapezoidal Slimes Agitator. Courtenay De Kalb. An illustrated description of a device used in California, with report of results. 1300 w. Eng & Min Jour—Feb. 11, 1904. No. 60786.

Smelting.

Notes on Smelting and Cupellation. F. L. Piddington. Describes the method generally used in the treatment of small parcels of rich material. 1500 w. Jour of Chem, Met & Min Soc of So Africa—Dec., 1903. No. 61009 E.

West Australia.

Recent Progress in West Australia. J. H. Curle. Concerning the gold fields of this region. 1600 w. Eng & Min Jour—Feb. 18, 1904. No. 61044.

Yukon.

The New Mayo Mining District. L. Netland. Illustrated article giving an account of the rich prospects revealed by the government survey of this new section of the Yukon territory, Canada. 3800 w. Pacific C Min—Jan. 30, 1904. No. 60621.

See also Electrical Engineering, Electrochemistry.

IRON AND STEEL.

Brittleness.

The Brittleness of Steel. H. le Chatelier. Remarks on the intermittent brittleness of steel, the causes, &c., discussing the nature of the metal, external conditions, and tests. 4000 w. Ir & Steel Met—Feb., 1904. No. 60733 D.

Cast Iron.

See Mechanical Engineering, Materials.

Converters.

Sideblown Steel Converters. N. Lilienberg. Extract from a paper read before the Philadelphia Foundrymen's Association. Discusses the advisability of erecting such a plant from the manufacturer's point of view, the advantages and disadvantages. 5000 w. Foundry—Feb., 1904. No. 60531.

Ferronickel.

Ferronickel Direct from Pyrrhotite. Ernst A. Sjötedt. Reviews the manner of manufacturing ferronickel direct from the Sudbury nickliferous pyrrhotite, illustrating the roasting furnace invented by the writer. 2500 w. Ir Age—Feb. 18, 1904. No. 60860.

Furnaces.

Coal-Fired Reverbatory Furnaces for Heating Iron and Steel. R. T. Cooke. Explains the principles of these furnaces and the methods of working and repairing. Ill. 1600 w. Prac Engr—Jan. 22, 1904. No. 60608 A.

Gas Furnaces.

Proportions of Regenerative Gas Furnaces, with Special Reference to Open-Hearth Furnaces. H. D. Hess. An illustrated article presenting the advantages of these furnaces, and discussing their management and construction. Short discussion. 5000 w. Pro Engrs' Club of Phila—Jan., 1904. No. 60762 D.

Heat Treatment.

The Semi-Solid State in Metals. Thos. Turner. Read before the Staffordshire Iron & Steel Inst. With special reference to the strength of cast-iron and the heat treatment of steel. 5400 w. Ir & St Trds Jour—Jan. 30, 1904. No. 60554 A.

Minnequa Works.

The Minnequa Works of the Colorado Fuel & Iron Company. Illustrated description of these large iron and steel works located at Pueblo, Colorado. 6000 w. Ir & Coal Trds Rev—Jan. 29, 1904. No. 60823 A.

Pig Iron.

Gases in Pig Iron (Ueber Gase im Roheisen). E. Nümkes. Describing the method of determining gases contained in melted pig iron; with results of analyses. 2500 w. Stahl u Eisen—Jan. 1, 1904. No. 60979 D.

Report.

Report of a Visit to the United States (Bericht über eine Studienreise nach den Ver. Staaten von Nordamerika). H. Macco. An account of a visit to the Minnesota ore deposits and the iron and steel furnaces of Western Pennsylvania; being a report to the Verein Deutscher Eisenhüttenleute. Two articles. 12000 w. Stahl u Eisen. Jan. 15, Feb. 1, 1904. No. 60-980 each D.

Rolling Mill.

Universal Rolling Mill of the Burbach Works (Universalwalzwerksanlage der Burbacher Hütte). Illustrating and describing an installation with direct-connected steam engine and hydraulically operated tables. 1200 w. 1 plate. Stahl u Eisen—Jan. 1, 1904. No. 60975 D.

Rolls.

Notes on the Design of Rolls. Emil

Kirchberg. From a paper printed in *Stahl und Eisen,* with additions. Notes on recent changes, influence of temperature, draft, reheating, &c. Ill. 4300 w. Ir & Coal Trds Rev—Jan. 22, 1904. No. 60633 A.

Separators.

Two New Magnetic Ore Separators (Zwei Neue Magnetische Erzscheider). Dr. Hecker. Describing the Forsgren and the Eriksson separators, used in the magnetite districts of Norway and Sweden. 1800 w. Glückauf—Jan. 23, 1904. No. 60-943 D.

Slag.

The Constitution of Ferromanganese Slags (Ueber die Zusammensetzung der Schlacken bei der Ferromanganerzeugung). F. Wittman. Giving a table of analyses of various slags, and a curve showing the relative percentages. 1000 w. Stahl u Eisen—Jan. 1, 1904. No. 60977 D.

Steel Castings.

See Mechanical Engineering, Materials.

MINING.

Ankylostomiasis.

Ankylostomiasis. Report of a recent debate in the German Reichstag. 3800 w. Col Guard—Jan. 29, 1904. Serial. 1st part. No. 60710 A.

Discussion upon the Hook Worm Disease (Verhandlungen über die Wurmkrankheit). A report of the discussion in the Reichstag upon the hook worm disease in the German mines, from the official stenographic notes. Special supplement. 50000 w. Glückauf—Jan. 23, 1904. No. 60945 D.

British Columbia.

Mining in British Columbia in 1903. Briefly reviews the progress made in each district, showing the development. 5000 w. Eng & Min Jour—Feb. 25, 1904. No. 61095.

The British Columbia Mining Industry in 1903. H. Mortimer Lamb. A review of the conditions influencing it during the past year. 6000 w. Mines & Min—Feb., 1904. No. 60629 C.

Detonators.

Testing Caps or Detonators in the Laboratory. A. W. Warwick. Describes a method by which a record of the strength and quality is automatically made. 2500 w. Mines & Min—Feb., 1904. No. 60624 C.

Drill.

The "Drillibite" Hand Rock-Drill. Illustrated detailed description of a portable drill-holder and turner aiming to enable one man to do the work of two when drilling holes by hand-power. 1500 w. Engng—Jan. 29, 1904. No. 60717 A.

Electricity.

Report of the Electricity in Mines Committee. Gives the report of the Committee presented to the Home Secretary, under date January 19, 1904, with copy of rules for the installation and use of electricity in mines. Also editorial. 18700 w. Col Guard—Feb. 5, 1904. No. 60821 A.

The Dangers of Electricity in Mining (Die Gefahren der Elektrizität im Bergwerksbetriebe). A review of the applications of electricity in mining, with especial reference to the possible ignition of fire damp. Serial, Part I. 1800 w. Glückauf—Jan. 30, 1904. No. 60947 D.

Explosion.

Gas Explosion at Boryslaw (Schlagwetterexplosion in Boryslaw). Johann Holobek. An account of the disastrous explosion of fire-damp in the Boryslaw mines, Galicia, Austria, June 2, 1902. Two articles, 1 plate. 4000 w. Oesterr Zeitschr f Berg u Hüttenwesen—Jan. 23, 30, 1904. No. 60942 each D.

Gravel Deposits.

Working Low-Lying Gravel Deposits by the Hydraulic Elevator System. R. H. Campbell. Illustrations of the latest improved Campbell hydraulic elevator, with remarks. 800 w. Min & Sci Pr—Feb. 13, 1904. No. 61031.

Haulage.

Electric Haulage in Metal Mines. W. N. Clark. Discusses the conditions of haulage in a metal mine, and describes the system used by the United Gold Mines Company of Victor, Colorado. 1700 w. Eng & Min Jour—Feb. 25, 1904. No. 61096.

Head Frames.

Simple Head Frame Construction. Shows a substantial frame constructed at the collar of a shaft, and explains the conditions. 1200 w. Min & Sci Pr—Feb. 6, 1904. No. 60866.

Hoisting.

The Pneumatic Hoist. M. Ehle, Jr. Discusses the value of the pneumatic system in hoisting from great depths. 1200 w. Min Rept—Feb. 11, 1904. No. 60855.

Kaffirs.

The Kaffir Mine-Workers. T. Lane Carter. Reports marked improvement in their efficiency, discussing the reasons, and outlining the methods of managing and caring for the miners. 1500 w. Eng & Min Jour—Feb. 18, 1904. No. 61047.

Mining Machinery.

The Development of Power-Driven Machinery in the Mine. E. H. Roberton. Discussing winding machinery, pumps, ventilating machinery, haulage systems, drills, coal cutters, etc. 3500 w. Engineering Magazine—March, 1904. No. 60994.

Ore Roasting.

Edwards' Mechanical Ore-Roasting Furnace. F. Danvers Power. Illustrates and describes the three types of Edwards furnaces. 2500 w. Eng & Min Jour.—Feb. 11, 1904. No. 60787.

Pumping Plant.

Pumping Plant at the Miike Collieries, Japan. Illustrates and describes probably the largest pumping plant ever erected on one shaft. 900 w. Engng—Jan. 29, 1904. No. 60713 A.

Sampling.

Automatic Ore Sampling. Alfred Harvey. Line drawings and description of an automatic ore sampling plant, designed to take a correct sample with the least possible crushing of the ore. 1500 w. Min & Sci Pr—Jan. 30, 1904. No. 60671.

Utah.

Mines and Aerial Tramways of the U. S. Mining Co., at Bingham, Utah. W. P. Hardesty. An illustrated detailed description. 5000 w. Eng. News—Feb. 11, 1904. No. 60788.

Ventilation.

Mine Ventilation. W. J. Mollison. Read before the Cent. Min. Inst. of W. Penn. Importance of improvement in methods, and some of the points which need to be considered to attain it. 2300 w. Mines & Min—Feb., 1904. No. 60628 C.

Winding Engine.

Compound Winding Engine at Sherwood Colliery. Charles H. Heathcote. Illustrated detailed description. 1600 w. Ir & Coal Trds Rev—Jan. 29, 1904. No. 60822 A.

Electrical Winding Engines. Dr. R. Herzfeld. Refers to several systems and gives particulars of the "Koepe Wheel," and the advantages of electrical transmission of power. Ill. 3000 w. Engng—Feb. 12, 1904. No. 60893 A.

Tests of Steam Winding Engines (Untersuchungen an Dampffördermaschinen). Dr. H. Hoffmann. An investigation of the varying loads upon mine hoisting engines, and the corresponding effects upon the steam machinery, with numerous load and indicator diagrams. Two articles. 8000 w. Zeitschr d Ver Deutscher Ing—Jan. 30, Feb. 6, 1904. No. 60920 each D.

MISCELLANY.

Metallurgy.

Metallurgy as Applied in Engineering. Archibald P. Head. Address delivered to the students of the Inst. of Civ. Engrs., demonstrating the importance of the study of metallurgy. 8800 w. Engng—Feb. 12, 1904. No. 60897 A.

Oil Deposits.

New Texan Oil Deposits. Day Allen Willey. Information concerning the petroleum deposits of Texas and Louisiana. 1500 w. Ills. Sci Am—Jan. 30, 1904. No. 60572.

Platinum.

Platinum in British Columbia. R. W. Brock. An account of the conditions under which platinum is found to occur in British Columbia, found thus far in only small quantities. 1400 w. Eng & Min Jour—Feb. 18, 1904. No. 61046.

Quantitative Analysis.

Notes on Quantitative Analysis for Mining Engineers. Edmund H. Miller. Notes representing the methods as at present taught, and showing what is required of mining students at Columbia University. 14500 w. Sch of Mines Qr—Nov., 1903. No. 60833 D.

Quicksilver.

A New Quicksilver Field in Brewster County, Tex. William B. Phillips. Gives the location of this new field, with particulars concerning the district. 1500 w. Eng & Min Jour—Jan. 28, 1904. No. 60556.

Tin.

Determination of Tin in Tailings and Slimes. George L. Mackenzie. Read before the Inst. of Min. & Met. Gives details of the scheme of assay employed by the writer. 2000 w. Mine Rept—Feb. 4, 1904. No. 60687.

Zinc.

The Joplin Zinc District. Joe Plyn. Gives the location and history and describes the peculiarities of the ore bodies, the methods of operating, prospecting, mining, milling and selling the ores. 3800 w. Mines & Min—Feb., 1904. No. 60630 C.

RAILWAY ENGINEERING

CONDUCTING TRANSPORTATION.

Accidents.

A Study of the Interstate Commerce Commission Accident and Safety-Appliance Reports. Extracts from the report of a committee of the Car Foremen's Ass'n of Chicago. 3000 w. R R Gaz—Feb. 5, 1904. No. 60683.

Technical Bureau.

A Central Technical Investigation Bureau for the Austrian Railways (Ein Technisches Zentral Studienbureau für das Eisenbahnwesen in Oesterreich). Dr. W. Exner. An examination of the project to establish a scientific bureau for the investigation of railway problems. 6000 w.

Zeitschr d Oesterr Ing u Arch Ver—Jan. 29, 1904. No. 60925 D.

Transportation.

Present Day Costs of Transportation by Rail and by Water. K. W. Blackwell. Presidential address before the Canadian Soc. of Civ Engrs. 2000 w. Eng News—Feb. 11, 1904. No. 60793.

Problems in Transportation by Rail in the United Kingdom. George Harrison Sheffield. Presidential address before the Newcastle-on-Tyne Assn. of Students of the Inst. of Civ. Engrs. Discusses needed improvements in rolling stock, electric power and other developments. 4200 w. R R Gaz—Feb. 12, 1904. No. 60797.

MOTIVE POWER AND EQUIPMENT.

Air Brakes.

Brake Retardation at Different Periods of the Stop. A discussion of the stop curve and the fact that the rate of retardation is much greater at the finish of the stop and less at the beginning. 700 w. Loc Engng—Feb., 1904. No. 60584 C.

The Pressure Retaining Valve: Its Value and Importance. F. H. Parke. An explanation of the results accomplished by this device, and an outline of the benefits when properly installed and maintained. 3800 w. R R Gaz—Jan. 29, 1904. No. 60566.

Axles.

Reports Upon an Investigation into the Stresses and Strains in Axles and Wheels in Service. F. B. Bissell. Shows the principal stresses and strains in axles and wheels, and how to so design that they may be taken safely. General discussion. Diagrams. 9000 w. Bro N Y R R Club—Jan. 15, 1904. No. 60831.

Cars.

A New 50-Ton Box Car. Illustrated description of a car with structural steel underframe, designed to meet special requirements in handling grain shipments. 1500 w. Am Engr & R R Jour—Feb., 1904. No. 60586 C.

Combination Dining, Parlor and Day Cars. Illustrated description of special cars designed for routes where the hauling of dining cars would not be justified. 800 w. Eng News—Feb. 18, 1904. No. 61039.

40-Ton Coal Car with Steel Underframe. Drawings, photographs and detailed description of some interesting cars recently constructed for a coal mining company. 800 w. R R Gaz—Feb. 5, 1904. No. 60682.

100,000 Lbs. Capacity Coal Cars—Chicago, Milwaukee & St. Paul Railway. Illustrated detailed description of the form of construction. 700 w. Ry Mas Mech—Feb., 1904. No. 60686.

Steel Cars on the Caledonian Railway of Scotland. Illustrations and descriptions of 30-ton cars recently put in service. 2200 w. R R Gaz—Feb. 19, 1904. No. 61034.

Steel Coke Car of Vanderbilt Design. Illustrated description of all-steel cars of large capacity. 450 w. Ry Age—Feb. 5, 1904. No. 60685.

The Modern Railway Wagon and the Details of Its Design. George Willans. A discussion of the present standard wagon specifications and their details, and high-capacity stock and future requirements. Ill. 1600 w. Prac Engr—Jan. 29, 1904. Serial. 1st part. No. 60700 A.

20-Ton Private Owners' Wagons. Official drawings and specification which are to regulate the construction of this class of rolling stock in England. 2500 w. Bul Int Ry Cong—Jan., 1904.—No. 60645 E.

Vanderbilt Steel Frame Tank Car. Drawings, photograph and detailed description. 6000 w. R R Gaz—Feb. 19, 1904. No. 61035.

Dynagraphs.

A Study of the Secondary Motions of Moving Cars (Etude des Mouvements sur les véhicules en Marche). M. Sabouret. A description of various recording instruments used for showing the lateral and other irregular motions of railway cars as used on the Western Railway of France. 6000 w. Rev Gen des Chem de Fer—Feb., 1904. No. 60952 H.

Electric Traction.

See Street and Electric Railways.

Locomotive Action.

The Destructive Action of Locomotive Engines (Die Störenden Bewegungen der Dampflokomotive). Herman Diepen. A mathematical investigation of the injurious inertia action of the moving parts of locomotives, including vibration, hammer-blow, etc. 6000 w. Glasers Annalen—Feb. 1, 1904. No. 60926 D.

Locomotives.

Asiatic Locomotives Constructed in Germany. Frank C. Perkins. Illustrations of two types, with brief notes. 300 w. Sci Am Sup—Feb. 20, 1904. No. 61053.

Blows and Pounds in Simple Locomotives. Discusses the causes, effects and remedies for these annoyances. 800 w. Loc Engng—Feb., 1904. No. 60583 C.

British Locomotive Work in 1903. Chas. Rous-Marten. A review of the principal characteristics of the work performed. 2500 w. Engr, Lond—Jan. 22, 1904. Serial. 1st part. No. 60619 A.

Centenary of the Locomotive Engine. W. B. Paley. Reviews the work of Richard Trevithick. 2500 w. R R Gaz—Feb. 12, 1904. No. 60794.

Compound Goods Locomotive, Saxony State Railways. Illustrated description of an engine of large power using superheated steam, and having features of interest. 2000 w. Engr, Lond—Jan. 22, 1904. No. 60620 A.

Four-Cylinder Balanced Compound Locomotives. A. von Borries. States the advantages of the writer's system, comparing with the de Glehn system. Ill. 1500 w. Engr, Lond—Jan. 29, 1904. No. 60718 A.

Locomotives for the Cape Government Railways. H. W. Hanbury. Full illustrated detailed description of two new six-wheel coupled engines, adapted for the use of superheated steam, on the Schmidt system. 3000 w. Engng—Jan. 22, 1904. No. 60615 A.

New York Central Pacific Type Locomotives. Illustrated detailed description of engines designed to handle fast trains. 1500 w. Ry & Engng Rev—Feb. 13, 1904. No. 60865.

Simple Consolidation Locomotive for N. Y. C. & H. R. R. R. Illustrations and general dimensions of engines designed for heavy, fast freight work. 700 w. Ry & Engng Rev—Jan. 30, 1904. No. 60578.

Switching Locomotive for the Pennsylvania Lines. Illustrated description of a 6-wheel switcher, Class B-6. 400 w. Ry Age—Jan. 29, 1904. No. 60543.

Ten-Wheel Express Locomotive for India, Built in Scotland. Illustration and leading dimensions. 400 w. Ry Age—Feb. 12, 1904. No. 60864.

The French Locomotive of the Great Western Railway. Charles Rous-Marten. An account of the first business trip of engine No. 102, La France. Not a trial trip. 1000 w. Engr, Lond—Feb. 5, 1904. No. 60829 A.

What Should be the Maximum Economical Load for a Locomotive? Charles T. Noyes. Considers the requirements of locomotive service. General discussion. 8000 w. Pro Pacific C Ry Club—Jan. 16, 1904. No. 60532 C.

Locomotive Tests.

Comparative Tests of Locomotives Using Saturated and Superheated Steam. Abstract of an article by Herr Strahl in *Zeitschrift des Vereins Deutscher Ingenieure*. Describes the experiments and gives results. Ill. 3300 w. R R Gaz—Feb. 19, 1904. No. 61036.

Indicator Tests of a Large Tandem Compound. Cards and data obtained from one of the tandem consolidation engines of the Santa Fe, showing the net tractive effort. 500 w. Am Engr & R R Jour—Feb., 1904. No. 60587 C.

Working Indicator Trials (Essais Effectués en Service Courant et à l'Aide d'Indicateurs de Pression). MM. Marchis and Ménétrier. Report of tests of 2-cylinder compound locomotive, with numerous indicator diagrams. 1000 w. 4 plates. Rev Gen des Chemins de Fer—Feb., 1904. No. 60953 H.

Railway Vehicles.

Automobile Railway Vehicles (Les Voitures Automotrices des Chemins de Fer). L. Turgan. Illustrating and describing various forms of self-propelled cars for special uses on railways, including both steam and petrol as motive power. 6000 w. 1 plate. Mem Soc Ing Civ de France—Nov., 1903. No. 60933 G.

The New Steam Automobile Car of the Northern Railway of France (La Nouvelle Voiture Automobile à Vapeur du Chemin der Fer du Nord). MM. Sartiaux and Koechlin. Illustrated description of steam motor car for railway service, with details of water-tube boiler, and running gear. 3500 w. 3 plates. Rev Gen des Chemins de Fer—Jan., 1904. No. 60951 H.

Relief Valve.

The Relief Valve as a Detriment to the Successful Operation of a Locomotive. G. W. Mudd. Gives the writer's theories in regard to this question. General discussion. 3000 w. St. Louis Ry Club—Jan. 8, 1904. No. 60737.

Repairs.

A Shop Schedule for Locomotive Repairs. Presents the schedule for locomotive repairs at the Chicago shops of the Chicago & Northwestern. 700 w. Am Engr & R R Jour—Feb., 1904. No. 60-588 C.

Stays.

Stays of Adjustable Length for Locomotives of the Danish State Railways. O. Busse. Translated from *Organ für die Fortschritte des Eisenbahnwesens*. Illustrates and describes a new system applied on these locomotives which allows the tube plate to expand freely. 700 w. Bul Int Ry Cong—Jan., 1904. No. 60641 E.

Trucks.

Side-Bearing Trucks. W. J. Knox. Illustrates a truck which aims to combine and improve the best features of both side-bearing and center-bearing trucks, and compares it with the regular center-bearing truck. 2000 w. Ry Age—Jan. 29, 1904. No. 60545.

NEW PROJECTS.

Europe-Pacific.

New Railway Between Europe and the Pacific. Dr. Convall Spatzier. Summary of an article in the Austrian magazine, *Die Reform*. Favors the construction of a new line to compete with the Russian line, showing the advantages. Map. 2000 w. Bul Int Ry Cong—Jan., 1904. No. 60643 E.

Improvements.

Big Four Revision Between Cincinnati and Sunman. Describes improvements made with a view to reducing the grades and rectifying the alignment between Lawrenceburg Junction and Sunman. Ill. 1400 w. Ry Age—Jan. 29, 1904. No. 60544.

PERMANENT WAY AND BUILDINGS.

Coal Chutes.

Coal Chutes for Locomotives. Illustrates and describes chutes used on the Baltimore & Ohio Railroad which are made to measure the coal delivered as accurately as it can be measured by volume. 1000 w. Am Engr & R R Jour—Feb., 1904. No. 60589 C.

Construction.

Construction, Equipment, Maintenance and Management of a Railroad. F. P. Roesch. Briefly considers these subjects. 4000 w. Pro Pacific C Ry Club—Jan. 16, 1904. No. 60754 C.

Construction Work of the Southern Indiana Railway. Illustrated description of construction work in the coal districts of Sullivan and Greene counties. 1800 w. Eng News—Feb. 25, 1904. No. 61084.

Notes on Railway Construction from the Resident Engineer's Standpoint. F. C. French. Slightly condensed paper read at the meeting of the Iowa Engng Soc. Calls attention to points of difference in the practice of a number of roads, in the hope of securing uniformity and of giving information to young engineers. 8000 w. Eng News—Feb. 4, 1904. No. 60674.

Flood Repairs.

Flood Repairs to the Lehigh & Susquehanna Division of the Central Railroad of New Jersey. M. A. Zook. Illustrations with description of repairs to roadbed and bridges. 1000 w. Eng News—Feb. 4, 1904. No. 60673.

Grade Crossings.

Grade Crossing Protection Between Steam and Electric Railways. Illustrates and describes the means of protection adopted by the Public Service Corporation of New Jersey. 800 w. Ry Age—Feb. 5, 1904. No. 60684.

Rails.

Researches on the Bending of Rails. A. Flamache. A study of this problem both under static and rolling loads. Mathematical. 8000 w. Bul Int Ry Cong—Jan., 1904. No. 60640 E.

Shops.

New Shops of the Chicago, Rock Island & Pacific Ry. at East Moline, Ill. An illustrated detailed description of a very interesting new plant. 4300 w. Eng News—Feb. 11, 1904. No. 60792.

Signalling.

Automatic Block Signals and Interlocking on the New York & Long Branch Railroad. Illustrates and describes a remarkable installation covering 37½ miles, and costing $175,000. 1000 w. Ry Age—Feb. 19, 1904. No. 61013.

Automatic Railway Signalling. Briefly reviews the power and automatic signalling systems, the methods of working, &c., and discusses the question of the normal position of signals. 3000 w. Engr., Lond—Feb. 12, 1904. Serial. 1st part. No. 61003 A.

Modern Power Signalling. Illustrated description of the electro-pneumatic signalling system, indicating the main principles. 1800 w. Engng Times—Feb., 1904. No. 61060 B.

Performance of Automatic Signals in Cold Weather. H. S. Balliet. A discussion of the more important failures during the severe weather of this winter. 1200 w. R R Gaz—Feb. 26, 1904. No. 61085.

Uneconomical Use of Block Signals. Editorial suggested by the address of Mr. Hope before the Ry. Signal Assn. 1000 w. R R Gaz—Feb. 26, 1904. No. 61087.

Terminals.

An Important New Terminal-Yard-Lighting and Power Plant. Illustrates and describes an installation in process of construction at Weehawken, N. J., for the West Shore R. R. 1600 w. Am Engr & R R Jour—Feb., 1904. Serial. 1st part. No. 60585 C.

The Cost of Handling Locomotives at Terminals. Charles H. Fry. Gives figures showing what these costs average for different roads in different parts of the country. 2000 w. R R Gaz—Feb. 19, 1904. No. 61032.

Turn-Table.

An All Cast-Iron Turn-Table. James C. Bennett. An illustrated description of a turn-table for industrial tracks, designed to increase the efficiency and lessen cost. 900 w. Eng & Min Jour—Feb. 4, 1904. No. 60652.

Widening.

Widening the Gauge of the National Railroad of Mexico. J. L. Bothwell. An account of the interesting features of this work. 800 w. Eng Rec—Feb. 20, 1904. No. 61020.

TRAFFIC.

British Railroads.

Stability of Traffic on British Railroads. Reviews an article published in *The Statist* (London) on the relative stability of the traffic on British railroads compared with that of other countries. 1000 w. R R Gaz—Jan. 29, 1904. No. 60568.

Rates.

Why Live Stock Carrying Rates Are Too Low. W. W. Cotton. Considerations presented at the convention in Portland, Ore., showing the costliness and hazard in connection with this class of traffic. 3500 w. Ry Age—Feb. 12, 1904. No. 60863.

MISCELLANY.

China.

The Railways of China. Arthur Judson Brown. An illustrated account of roads built and under construction, the difficulties met, and related matters of interest. 3500 w. Rev of Revs—Feb., 1904. No. 60528 C.

Economy.

Economy in Railroad Operations. W. B. Waggoner. Outlines the general situation and offers suggestions based on study and experience. General discussion. 12600 w. Pro W Ry Club—Jan. 19, 1904. No. 60804 C.

Franchise Values.

Railroad Franchise Values in Texas. W. H. Coverdale. Remarks on the methods of the Texas Commission in the matter of valuation. 1000 w. R R Gaz—Feb. 12, 1904. No. 60798.

Railway Inventions.

What the Inventor has Done for the Railway Worker. Arthur M. Waitt. Discussing improvements in permanent way, rolling stock, motive power, and details of railway operation. 3000 w. Engineering Magazine—March, 1904. No. 60989 B.

Valuation.

Methods Used by the Railroad Commission of Texas, Under the Stock and Bond Law, in Valuing Railroad Properties. R. A. Thompson. Report of this law and the railroads valued since its passage, describing the methods used. 5400 w. Pro Am Soc of Civ Engrs—Jan., 1904. No. 60742 E.

STREET AND ELECTRIC RAILWAYS

Air Brakes.

Storage Air Brake System in St. Louis. Illustrates and describes the system adopted, considering the particulars and reasons for the choice of this type. 2500 w. St Ry Jour—Feb. 6, 1904. No. 60691 D.

Brooklyn.

Traffic Conditions on the Brooklyn Rapid Transit System. C. R. Barnes. Abstract of report of the electrical expert of the Railroad Commissioners of the State of New York. 3000 w. St Ry Jour—Feb. 20, 1904. No. 61018 C.

Bulgaria.

Electric Tramways of Sofia. Illustrated description of tramways operated by means of a high tension water power station with low tension steam power station for reserve. 1400 w. St Ry Rev—Feb. 20, 1904. No. 61078 C.

Construction.

Notes on the Construction of an Electric Road and Power-House at Morgantown, West Virginia. Walter Loring Webb. An illustrated description of the construction of a road where the conditions were in some respects unusual, the question of grade having much influence on the route. Discussion. 4700 w. Pro Engrs' Club of Phila—Jan., 1904. No. 60761 D.

Contact Rails.

Preliminary Work in Laying Out a Contact Rail System. William A. Del Mar. Deals with the practical problems with which a draughtsman has to contend when preparing to lay out a system of contact rails. 900 w. Am Elect'n—Feb., 1904. No. 60596.

Electric Traction.

Electric Power for Railways. B. S. Lanphear. Read before the Iowa Engng. Soc. A brief review of early electric railroading, and its progress. 1700 w. Elec Rev, N. Y.—Feb. 20, 1904. No. 61015.

The Future of Electric Traction on Main-Line Railways (Considerations sur l'Avenir de la Traction Electrique sur les Grandes Lignes de Chemins de Fer). R. Bonnin. A comparison of the results attained upon local and municipal railways with the requirements for main-line service. Two articles. 6000 w. Revue Technique—Jan 10, 25, 1904. No. 60909 each D.

Ilford.

Ilford Corporation Tramways. Illustrated description of a line forming a part of the suburban tramway system of London. 4000 w. Tram & Ry Wld—Feb. 11, 1904. No. 61074 B.

Interurban.

The Conneaut & Erie Interurban System. Illustrated detailed description of the line and equipment. 4000 w. St Ry Jour—Feb. 6, 1904. No. 60690 D.

Italy.

Main Line Electric Traction in Italy (Elektrische Vollbahnen in Italien). Pietro Lanino. A general description of the satisfactory operation of the lines in northern Italy. 4500 w. Elektrotech Zeitschr—Feb. 11, 1904. No. 60964 B.

"Key Route."

The San Francisco, Oakland & San Jose Railway—"The Key Route." Illustrated description of an electric railway having interesting features, and operating trains instead of single cars. 3500 w.

St Ry Jour—Feb. 13, 1904 Serial. 1st part. No. 60848 C.

London.

London's New Tube Railroad. C. H. Grinling. Information concerning the Great Northern & City Railway, recently completed. Ill. 1400 w. R R Gaz—Jan. 29, 1904. No. 60567.

The Electrification of the Metropolitan Railway. The first of a series of illustrated articles showing the progress that has been made in the electrical equipment of this road. 2000 w. Engr, Lond—Feb. 12, 1904. Serial. 1st part. No. 61002 A.

Los Angeles.

Los Angeles Traction and California Pacific Railway Companies. Samuel B. McLenegan. Brief illustrated description of this line. 2200 w. Jour of Elec, Power, & Gas—Jan., 1904. No. 60769 C.

The Los Angeles and Pacific Railway Companies. Illustrated description of the construction, equipment and engineering features. 6000 w. Jour of Elec, Power & Gas—Jan., 1904. No. 60768 C.

Measuring Car.

The Measuring Car of the Berlin Tramways (Messwagen der Grosser Berliner Strassenbahn). Emil Björkegren. A fully illustrated description of a trolley car carrying a switchboard and complete set of instruments for local testing. 2000 w. Elektrotech Zeitschr—Jan. 28, 1904. No. 60959 B.

Oregon.

The Oregon Water Power and Railway Company. George I. Brown. An illustrated article reviewing the history and describing the property of this company, which operates steel car, suburban, interurban, and heavy freight traffic. 4000 w. Jour of Elec, Power, & Gas—Jan., 1904. No. 60770 C.

Paris.

Electric Railway Construction in Paris. Francis Paul. Illustrates and describes the conduit system of the General Parisian Tramways Company. 4000 w. Am Elect'n—Feb., 1904. No. 60593.

Power Equipment.

Improvements in the Power Equipment of the Cleveland & Southwestern System. Illustrated description of one of the first steam turbine installations for electric railway work in the United States. 7500 w. St Ry Jour—Jan. 30, 1904. No. 60546 C.

Providence, R. I.

Manchester Street Power Station of the Rhode Island Company, Providence. Illustrated description of a plant of special interest because of the arrangements and details of the machinery and apparatus, and the fireproof construction of fine design. 2700 w. Eng Rec—Feb. 20, 1904. Serial. 1st part. No. 61023.

Railway Power Plant at Providence, R. I. Illustrates and describes a new station, having a capacity of 10,500 Kw. Both direct and alternating current is furnished. 4800 w. St Ry Jour—Feb. 20, 1904. No. 61017 C.

Rail Welding.

Electric Rail Welding on the Glasgow Tramway System. Benjamin Taylor. Illustrated description of the work as carried out by the Lorain Steel Company, of Lorain, Ohio. 2500 w. Engng Rev—Feb., 1904. No. 61065 B.

San Francisco.

The United Railroads of San Francisco. An illustrated account of these lines, their features of interest and equipment. 6000 w. Jour of Elec, Power & Gas—Jan., 1904. No. 60771 C.

Single-Phase.

Single-Phase Electric Traction (Traction Electrique avec Moteurs Monophasés). E. Dieudonné. A review of recent experiments in Europe and America. 2000 w. Revue Technique—Jan. 10, 1904. No. 60907 D.

Steel Cars.

Interborough Rapid Transit All-Steel Cars. Illustrated detailed description of an experimental car now in use on the Second Ave. line in New York, of a type proposed for the subway. 400 w. Ry Age—Feb. 19, 1904. No. 61012.

Steubenville, O.

The Railway System of the Steubenville Traction & Light Co. Illustrates and describes this company's system and power house which includes a gas-producing plant, an electric lighting plant, and an electric traction plant. 6500 w. St Ry Rev—Feb. 20, 1904. No. 61079 C.

Switzerland.

The Street Railway System of Schaffhausen, Switzerland. Illustrates and describes one of the most prominent Swiss installations. 1800 w. St Ry Jour—Feb. 13, 1904. No. 60849 C.

Third Rail.

The Third Rail System of the North Shore Railroad. George P. Low. Illustrated detailed description of an important electric railway line in California. 8500 w. Jour of Elec, Power & Gas—Jan., 1904. No. 60767 C.

Trucks.

Development of the Brill System of Trucks for Electric Motor Cars. William H. Heulings, Jr. An interesting illustrated account, with discussion. 4500 w. Pro Engrs' Club of Phila—Jan., 1904. No. 60759 D.

EXPLANATORY NOTE—THE ENGINEERING INDEX.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language*, together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. Certain journals, however, make large extra charges for back numbers. In such cases we may have to increase proportionately the normal charge given in the Index. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

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CARD INDEX.—These pages are issued separately from the Magazine, printed on one side of the paper only, and in this form they meet the exact requirements of those who desire to clip the items for card-index purposes. Thus printed they are supplied to regular subscribers of THE ENGINEERING MAGAZINE at 10 cts. per month, or $1.00 a year; to non-subscribers, 25 cts. per month, or $3.00 a year.

THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* Boston.
American Electrician. *m.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Jl. of Science. *m.* New Haven, U.S.A.
American Machinist. *w.* New York.
American Shipbuilder. *w.* New York.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. d Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *qr.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Sydney.
Autocar. *w.* Coventry, England.
Automobile. *m.* New York.
Automobile Magazine. *m.* New York.
Automotor Journal. *w.* London.
Beton und Eisen. *qr.* Vienna.
Brick Builder. *m.* Boston.
British Architect. *w.* London.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bulletin American Iron and Steel Asso. *w.* Philadelphia, U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. Soc. Int. d Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bull. Int. Railway Congress. *m.* Brussels.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Montreal.
Canadian Mining Review. *m.* Ottawa.
Cassier's Magazine. *m.* New York.
Central Station. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *m.* Chicago.
Electrical Engineer. *w.* London.
Electrical Review. *w.* London.

Electrical Review. *w.* New York.
Electrical World and Engineer. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *w.* New York.
Electrochemical Industry. *m.* New York.
Electrochemist and Metallurgist. *w.* London.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricità. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Chicago.
Engineering. *w.* London.
Enginering and Mining Journal. *w.* New York.
Enginering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penna. *m.* Pittsburg, U.S.A.

Fire and Water. *w.* New York.
Foundry. *m.* Cleveland, U. S. A.

Gas Engineers' Mag. *m.* Birmingham.
Gas World. *w.* London.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e. d. Str. Ferr. *w.* Rome.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.

Ice and Refrigeration. *m.* New York.
Ill. Zeitschr. f. Klein u. Strassenbahnen. *s-m.* Berlin.
Ingenieria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron and Steel Metallurgist. *m.* Boston.
Iron and Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.

Jour. Am. Foundrymen's Assoc. *m.* New York.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Journal of Sanitary Institute. *qr.* London.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery *b-m.* Fort Monroe, U.S.A.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, U.S.A.

Locomotive. *m.* Hartford, U. S. A.
Locomotive Engineering. *m.* New York.

Machinery. *m.* New York.
Madrid Cientifico. *t-m.* Madrid.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U. S. A.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Metal Worker. *w.* New York.
Métallurgie. *w.* Paris.
Minero Mexicano. *w.* City of Mexico.
Minerva. *w.* Rome.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci Press. *w.* San Francisco.
Mining Reporter. *w.* Denver, U. S. A.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
Modern Machinery. *m.* Chicago.
Mouvement Maritime. *w.* Brussels.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *m.* New York.

Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Nineteenth Century. *m.* London.
North American Review. *m.* New York.

Oest. Wochenschr. f. d. Oeff Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg- & Hüttenwesen. *w.* Vienna.
Ores and Metals. *w.* Denver, U. S. A.

Pacific Coast Miner. *w.* San Francisco.
Page's Magazine. *m.* London.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Procedings Engineers' Club. *qr.* Philadelphia.
Pro. St. Louis R'Way Club. *m.* St. Louis, U. S. A.
Progressive Age. *s-m.* New York.

Quarry. *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.

Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago.
Review of Reviews. *m.* London & New York.
Revista d Obras. Pub. *w.* Madrid.
Revista Tech. Ind. *m.* Barcelona.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Gen. des Sciences. *w.* Paris.
Revue Industrielle. *w.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Gen. d Ferrovie. *w.* Florence.
Rivista Marittima. *m.* Rome.

Schiffbau. *s-m.* Berlin.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Engng. *m.* Ithaca, N. Y.
Stahl und Eisen. *s-m.* Düsseldorf.
Stevens' Institute Indicator. *qr.* Hoboken, U.S.A.
Stone. *m.* New York.
Street Railway Journal. *m.* New York.
Street Railway Review. *m.* Chicago.

Tijds. v h Kljk. Inst. v Ing. *qr.* Hague.
Traction and Transmission. *m.* London.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining. Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Transport. *w.* London.

Wiener Bauindustrie Zeitung. *w.* Vienna.
World's Work. *m.* New York.

Yacht. *w.* Paris.

Zeitschr. d. Mitteleurop. Motorwagen Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a S.
Zeitschr. f. Electrotechnik. *w.* Vienna.

CURRENT RECORD OF NEW BOOKS

NOTE—*Our readers may order through us any book here mentioned, remitting the publisher's price as given in each notice. Checks, Drafts, and Post Office Orders, home and foreign, should be made payable to* THE ENGINEERING MAGAZINE.

Gas Engines.

The Gas Engine. A Treatise on the Internal-Combustion Engine Using Gas, Gasoline, Kerosene or other Hydrocarbon as Source of Energy. By Frederick Remsen Hutton, E. M., Ph. D. Size, 9 by 6 in.; pp. xviii, 483; figures, 243. Price, $5. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

In recent years the internal combustion engine has become of great commercial importance, and while it does not at present rival the steam engine in numbers or amount of energy developed, its future is most promising, and it may yet outdistance the older prime mover. Together with the constructive advance of the internal-combustion engine, there has grown up a body of literature concerning its various forms, both in the pages of engineering periodicals and in books, but there was still ample room for a treatise such as the present one, systematically covering the subject, especially the theoretical part. Prof. Hutton starts in with the consideration of the energy contained in fuels of various kinds, and methods for the liberation of this energy and its conversion into useful work. The cycles of heat engines are touched upon in one of the earlier chapters, but the complete discussion of this topic is postponed until a later section of the book, when the theoretical analysis of the gas engine is treated pretty exhaustively, and all the possible cycles of the internal-combustion engine are classified. On the practical side, the principal types of gas, gasoline, kerosene and alcohol motors are described, and there are chapters on the proportioning of mixtures, carburation, ignition, governing, cooling, the manipulation of internal-combustion engines, and their testing. In a chapter on internal-combustion engines with heating at constant pressure, the recent work of Dr. Charles E. Lucke is summarized, and his apparatus for the continuous combustion of explosive mixtures is described. There are also descriptions of the Brayton and other types of engine which have operated with constant-pressure heating, and the future of such engines, including the gas turbine, is indicated. A record of tests of explosive mixtures is given, and the book concludes with a historical summary and a bibliography.

Marine Engineering.

A Manual of Marine Engineering: Comprising the Design, Construction and Working of Marine Machinery. By A. E. Seaton. Fifteenth Edition. Size, 9 by 6½ in.; pp. xxiii, 707; fully illustrated with plates and figures in the text. Price $6 (21s.). London: Charles Griffin and Co., Ltd. New York: D. Van Nostrand Co.

No better proof of the progress which has been made in marine engineering in the last quarter century can be found than by comparing the present edition of Mr. Seaton's manual with its first issue in the early eighties. At that time, the triple-expansion engine had hardly advanced beyond the experimental stage, boiler pressures of 100 pounds to the square inch were thought excessive, and steel as a constructive material for both engines and hull was considered a luxury. To-day, quadruple-expansion engines with five cylinders, steam pressures of 300 pounds, and the almost universal use of steel are among the features of modern marine engineering which mark the great advance. It has required frequent editions of the present work to keep pace with the art it describes, and this latest issue has been thoroughly revised, enlarged and in part re-written to bring it up to modern standard practice. The very newest developments, such as the steam turbine and oil fuel, are only briefly described, but the reciprocating engine and the steam boiler and all their details and accessories are very fully treated. Among the special subjects discussed are water-tube boilers, including all the standard types; the balancing of marine engines; the resistance of ships and the power necessary to drive them at different speeds; the design and construction of propellers; pumps; sea cocks, valves, steam-steering gears and other auxiliary machinery; oil and lubricants; and the materials used by the marine engineer. The book is very fully illustrated with plates and figures in the text, there are many tables, an appendix contains Lloyd's and other rules for boilers and other apparatus, and an index completes a work which is of great value and interest, and whose popularity is well attested by the fact that it has passed through fifteen editions in little more than twenty years.

Valve Gears.

The Lay-Out of Corliss Valve Gears. By Sanford A. Moss, M. S., Ph. D. Reprinted from *The American Machinist* with Revisions and Additions. Size, 6 by 3¾ in.; pp. 108; plates 3, figures 8. Price, 50 cents. New York: D. Van Nostrand Company.

Although the Corliss valve gear in its various forms has had the widest application in practice, it has not been adequately treated from a theoretical point of view until the appearance of the present work, in which is given a complete discussion of the principles underlying the kinematic design, or "lay-out," and also explicit directions for making a lay-out on the drawing board. The methods employed are such as may be used with success by any one who has mastered the fundamental principles, in contradistinction to the ordinary rule-of-thumb directions, which give good results only in the hands of experienced designers. A clear description of the Corliss valve-gear mechanism and its operation forms an introduction to the theoretical part of the book, which is then developed in several chapters, with diagrams, in a way that will be of great interest and value to the student and the designer of Corliss engines.

Wireless Telegraphy.

Maver's Wireless Telegraphy: Theory and Practice. By William Maver, Jr. Size, 9 by 6 inches; pp. vi, 205; figures, 123. Price, $2. New York: Maver Publishing Co.

Those who are trying to keep pace with the advances in wireless telegraphy will welcome the present volume, which gives a very good account of the development of this new art and of its present state, and affords a secure starting point from which to follow its further progress. The author is a telegraph engineer of long standing, is also the author of the standard work, "American Telegraphy and Encyclopedia of the Telegraph," and has had considerable experience in the operation of wireless telegraph systems, so that he writes with a first-hand knowledge of his subject and an appreciation of the many practical points which are felt only by actual contact with them. After the introductory portion of the book, in which, among other things, the induction-telegraph systems of Phelps, Edison, Preece, etc., are described, the theory of Hertzian-wave telegraphy, on which the modern "wireless" systems are founded, is discussed. Then follow detailed accounts of the systems of Marconi, De Forest, Lodge-Muirhead, Slaby-Arco, Braun, Branly-Popp, Fessenden, Stone, Shoemaker and various other inventors. Signaling by ultra-violet light and light telephony are also described, and a chapter is devoted to theoretical and practical notes on wave detectors, interrupters, transformers, oscillators, the spark gap, condensers, and the antennae, or aerial wires. As wireless telegraphy has grown so rapidly, even while this book was being written, the most recent developments of some of the systems appear in different places from the descriptions of their fundamental features, but this is taken care of by cross references in the text and by a full index. The book is written in plain language, as free from abstruse technicalities as possible, and has many diagrams and other illustrations, so that it will be of interest to the general reader who wishes to keep in touch with this fascinating branch of electrical engineering, as well as of great value to the technical men who themselves are pushing this work so rapidly ahead.

BOOKS RECEIVED.

A Treatise on Friction and Lost Work in Machinery and Millwork. By Robert H. Thurston, M. A., LL. D., Dr. Eng'g. Seventh Edition. Price, $3. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

Proceedings of the Society for the Promotion of Engineering Education. Vol. XI. Price, $2.50. New York: Engineering News Publishing Co.

American Meter Practice. By Lyman C. Reed. Price, $2. New York: McGraw Publishing Co.

Points for Buyers and Users of Tool Steel. By George W. Alling, M. E. Price, $2. New York: David Williams Company.

Free-Hand Lettering. By Victor T. Wilson, M. E. Price, $1. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

Moderne Gesichtspunkte für den Entwurf Elektrischer Maschinen und Apparate. By Dr. F. Niethammer. Price, 8 marks ($2.50). Munich and Berlin: R. Oldenbourg.

Reflections on Heating and Ventilating Engineering. By Konrad Meier. New York: Konrad Meier, 27 East 22nd Street.

Facts About Peat, Peat Fuel and Peat Coke. By T. H. Leavitt. Price, postpaid, $1.10. Boston: Lee and Shepard.

Alternating Currents: Their Generation, Distribution and Utilization. By George T. Hanchett. Price, $1. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

Machine Design. Part I. Instruction Paper prepared by Charles L. Griffin. Chicago: American School of Correspondence Instruction at Armour Institute of Technology.

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A COMPARISON OF AMERICAN AND EUROPEAN COMMERCIAL CONDITIONS.

By William J. Clark.

Mr. Clark is the manager of foreign trade of one of the very largest American electric companies. He therefore expresses conclusions based upon an unrivalled fund of observation and experience.—The Editors.

THE question is frequently asked "what are the most effective methods for increasing America's foreign trade?" A proper reply would be: "Take advantage of existing conditions and the natural laws of trade will accomplish the rest."

The object of this article is to give a true appreciation of some of these existing conditions in various countries, and as it is desired to state them as briefly as possible, there is necessity for using a number of statistical tables.

The balance of trade on exports and imports is an excellent standard by which to gauge the prosperity of nations, their commercial progress, and their position. It is by no means the only one, as subsequently shown; yet as it is the most frequently used, the tables on the following three pages are here inserted, that at the outset the conditions of the more important countries in this respect may be noted.

Balance of trade on exports and imports, important as it is, does not determine the net results to any nation from its financial and commercial relations abroad. The old and rich countries of Europe doubtless receive returns from their enormous foreign investments that more than offset the balances of trade which are against them; but it is, naturally, impossible to secure, or even to approximate, figures thereon.

IMPORTS AND EXPORTS OF MERCHANDISE OF THE PRINCIPAL COUNTRIES, 1892.

COMPILED FROM STATISTICS OF U. S. DEPARTMENT OF COMMERCE AND LABOR.

COUNTRIES.	IMPORTS.	EXPORTS.	TOTAL FOREIGN TRADE.	EXCESS OF IMPORTS OVER EXPORTS, i. e. Balance of Trade against Nation, with per cent. on total Foreign Trade.		EXCESS OF EXPORTS OVER IMPORTS, i. e. Balance of Trade in favor of Nation, with per cent. on total Foreign Trade.	
Argentina	$88,279,322	$109,402,375	$197,681,697			$21,123,053	10.7 %
Australia (Commonwealth of)	146,517,370	162,396,487	308,913,857			15,879,117	5.14
Austria-Hungary	252,763,703	293,424,916	546,188,619			40,661,213	7.45
Belgium	296,536,000	264,302,000	560,838,000	$32,234,000	5.74%		
Bulgaria	14,919,000	14,406,000	29,325,000	513,000	1.75		
Canada	115,170,830	105,488,798	220,659,628	9,682,032	4.		
Cape of Good Hope	58,290,840	46,170,126	104,460,966	12,120,174	11.62		
Chile	60,074,090	49,447,550	109,521,600	10,626,580	9.7		
China	141,315,853	107,302,367	248,618,220	34,013,486	13.64		
Denmark	86,976,000	67,621,000	154,597,000	19,355,000	12.52		
Egypt	44,939,191	65,946,135	110,885,326	21,006,944	18.92		
France	808,295,000	667,922,000	1,476,217,000	140,373,000	9.51		
Germany	956,415,000	703,078,000	1,659,493,000	253,337,000	25.26		
Greece	23,026,000	15,876,000	38,902,000	7,150,000	18.38		
India (British)	190,417,113	310,074,240	500,491,353			119,657,127	23.91
Italy	226,464,653	184,930,133	411,394,786	41,534,520	10.39		
Japan	50,321,521	63,825,743	114,147,264			13,504,222	11.85
Mexico	42,714,180	58,018,597	100,737,677			15,304,417	15.19
Netherlands	510,138,402	454,141,193	964,279,595	55,997,209	5.81		
Norway	53,596,500	31,847,200	85,443,700	21,749,300	25.47		
Portugal	33,295,000	26,601,000	59,896,000	6,694,000	11.18		
Russia	202,947,970	378,452,580	581,400,550			175,504,610	30.21
Spain	143,511,874	128,450,186	271,962,060	15,061,688	5.54		
Sweden	96,220,000	87,998,000	184,218,000	8,222,000	4.47		
Switzerland	167,796,208	126,926,299	294,722,557	40,869,909	13.83		
United Kingdom	1,969,415,018	1,062,160,918	3,031,575,936	907,254,100	29.94		
United States	776,248,924	854,729,454	1,630,978,378			78,480,530	4.81
Uruguay	19,030,000	26,834,000	26,834,000	45,864,000		7,804,000	17.

YEAR 1902.

COUNTRIES.	IMPORTS.	EXPORTS.	TOTAL FOREIGN TRADE.	EXCESS OF IMPORTS OVER EXPORTS, i. e. Balance of Trade against Nation, with per cent. on total Foreign Trade.		EXCESS OF EXPORTS OVER IMPORTS, i. e. Balance of Trade in favor of Nation, with per cent. on total Foreign Trade.	
Argentina	$99,432,882	$173,204,692	$272,637,574			$73,771,810	26.7 %
Australia (Commonwealth of)	197,960,650	213,713,452	411,674,102			15,752,802	3.85
Austria-Hungary	349,283,319	387,525,845	736,809,164			38,242,526	5.19
Belgium	459,472,000	371,620,000	831,092,000	$87,852,000	10.57%		
Bulgaria	13,751,000	20,011,000	33,762,000			6,260,000	18.54
Canada	224,810,528	214,401,674	439,212,202	10,408,854	2.37		
Cape of Good Hope	156,261,393	77,051,256	233,312,649	79,210,137	33.95		
Chile	48,336,294	67,846,187	116,182,481			19,509,893	16.70
China	198,363,896	134,720,216	333,084,112	63,643,680	19.11		
Denmark	151,349,000	85,730,000	237,079,000	65,619,000	23.		
Egypt	73,229,003	87,080,846	160,309,849			13,851,843	8.66
France	848,045,700	820,671,000	1,668,716,700	27,374,700	1.62		
Germany	1,340,178,000	1,113,313,000	2,453,491,000	226,865,000	9.24		
Greece	26,034,000	15,466,000	41,500,000	10,568,000	25.47		
India (British)	255,614,237	408,295,874	664,010,111			152,781,637	23.
Italy	342,718,351	284,174,782	626,893,133	58,543,560	9.32		
Japan	135,117,083	127,326,158	262,443,241	7,790,925	2.07		
Mexico	74,690,331	88,190,632	162,880,963			13,500,301	8.28
Netherlands	867,307,701	732,975,255	1,600,282,956	134,332,446	8.4		
Norway	78,869,000	45,146,500	124,015,500	33,722,500	27.10		
Portugal	60,459,000	31,868,000	92,327,000			28,591,000	30.07
Russia	305,614,110	392,214,088	697,829,098	28,591,000	30.07	86,600,878	12.4
Spain	175,499,321	154,164,194	329,663,515	21,235,127	6.10		
Sweden	134,603,000	105,154,000	239,757,000	29,449,000	12.25		
Switzerland	217,802,568	168,740,886	386,343,454	49,061,682	12.60		
United Kingdom	2,642,053,631	1,415,617,552	4,057,671,183	1,226,436,070	30.25		
United States	995,447,175	1,457,575,865	2,453,023,040			62,128,690	18.84
Uruguay	24,565,000	33,656,000	58,221,000			9,091,000	17.34

COMPARISONS OF YEARS 1892 AND 1902.

COUNTRIES.	INCREASE OF IMPORTS, WITH PER CENT. 1902 OVER 1892.		INCREASE OF EXPORTS, WITH PER CENT. 1902 OVER 1892.		INCREASE OF TOTAL FOREIGN TRADE, WITH PER CENT. 1902 OVER 1892.		PERCENTAGE OF BALANCE OF TRADE AGAINST NATION.		PERCENTAGE OF BALANCE OF TRADE IN FAVOR OF NATION.	
							1892.	1902.	1892.	1902.
Argentina	$11,153,560	12.63	$63,802,317	58.32	$74,955,877	37.91			10.7	26.7
Australia (Commonwealth of)	51,443,280	35.11	51,316,965	31.60	102,760,245	33.25			5.14	3.85
Austria-Hungary	96,519,616	38.18	94,100,929	32.07	190,620,545	36.72			7.45	5.19
Belgium	162,936,000	54.94	107,318,000	40.60	270,254,000	42.83	5.74	10.57		
Bulgaria (Decrease)	1,168,000	7.83	5,605,000	38.91	4,437,000	15.20	1.75			18.54
Canada	109,639,698	95.20	108,912,876	103.25	218,552,574		4.00	2.37		
Cape of Good Hope	97,970,553	168.08	30,881,126	66.89	128,851,679	123.42	11.62	33.95		
Chile (Decrease)	11,737,796	19.54	18,398,677	37.21	6,660,881		9.7			16.79
China	57,048,043	40.37	27,417,849	25.55	84,465,892	34.06	13.64	19.11		
Denmark	64,373,000	74.01	18,109,000	26.78	82,482,000	53.35	12.52	23.84		
Egypt	28,289,812	62.95	21,134,711	32.05	49,424,523	44.93	18.92			8.66
France	39,750,700	4.92	152,749,000	22.87	192,499,700	13.	9.51	1.62		
Germany	383,763,000	40.13	410,235,000	58.35	793,998,000	47.86	25.26	9.21		
Greece	3,008,000	13.06	(Dec) 410,000	2.58	2,598,000	6.68	18.38	25.47		
India (British)	65,197,124	34.24	98,321,634	31.71	163,518,758	32.7			23.91	23.06
Italy	116,253,698	51.34	99,244,649	53.67	215,498,347	52.43	10.39	9.32		
Japan	84,795,562	168.51	64,500,415	99.49	149,295,977	130.		2.97	11.85	
Mexico	31,976,251	74.86	30,181,035	52.02	62,157,286	52.15			15.19	8.28
Netherlands	357,169,299	70.01	278,834,062	61.40	636,003,361	65.98	5.81	8.4		
Norway	25,272,500	47.15	13,299,300	41.76	38,571,800	45.15	25.47	27.19		
Portugal	27,164,000	81.59	5,267,000	19.80	32,431,000	54.15	11.18	30.97		
Russia	102,666,140	50.59	13,762,408	3.63	116,428,548	50.			30.21	12.4
Spain	31,987,447	8.17	25,714,008	8.33	57,701,455	21.21	5.54	6.19		
Sweden	38,383,000	7.12	17.156,000	8.37	55,539,000	30.18	4.47	12.25		
Switzerland	50,006,360	29.80	41,814,587	32.94	91,820,947	31.16	13.83	12.69		
United Kingdom	672,638,613	34.15	353,456,634	33.28	1,026,095,247	33.86	29.94	30.25		
United States	219,198,251	22.24	602,846,411	70.73	822,044,662	50.31			**4.81**	**18.84**
Uruguay	5,535,000	29.09	7,822,000	25.42	13,357,000	26.95			**17.00**	**17.34**

An important feature, however, in determining the net positions of nations in their international trade, and one which can be closely approximated, is the earnings of their ocean carriers, viewed in connection with their balance of trade. Not all of these earnings are clear gain to a country's wealth, as is the balance of trade in its favor on exports and imports; for naturally, a nation pays to itself or to someone else, either directly or indirectly, the expense of transporting its imports, and available statistics do not separate coastwise from foreign commerce of all countries; yet from the following table important conclusions can be drawn as to the earnings of various countries from their vessels engaged in ocean traffic, most of these being employed in foreign trade.

The tonnage of vessels given is from Lloyd's Register; the earnings are estimated at the rate of $10 per rated ton on sailing vessels, and $40 per ton on steamers, which sums various authorities agree are a close approximation to actual results.

TOTAL TONNAGE AND APPROXIMATE EARNINGS OF MERCHANT SHIPPING OF THE WORLD.

EXCLUDING LAKE TRAFFIC OF THE UNITED STATES.

1900—1904.

COUNTRIES.	TONNAGE. Gross. Steam.	TONNAGE. Sailing. Net.	EARNINGS. Approximate Annual.
Argentina	70,862	24.918	$3.083.660
Austria-Hungary	557.745	20.952	22,519.320
Belgium	156.559	488	6.267.240
Brazil	132,107	22.979	5.514.070
Chile	67,186	36.572	3.053,160
China	60.491	....	2.419.640
Cuba	38,550	2,324	1,565.240
Denmark	483,968	97.279	20,331,510
Netherlands	613,219	45.626	24.085,020
France	1,153,761	468,255	50.832.090
Germany	2,794.311	488.036	116.661.800
Greece	325,895	52,304	13.558.840
Italy	704,109	476,266	32.927,020
Japan	585,542	141,276	24.834,440
Mexico	15.210	3.678	645.180
Norway	935.229	718.511	44.594.270
Philippine Islands	43.138	8,261	1.808.130
Portugal	51.217	50,087	2.549.550
Roumania	16.600	634	670.340
Russia	578.343	231.305	25.416.770
Spain	720,822	43.625	29.260,130
Sweden	502.581	218.535	22.288.590
Turkey	92.860	61.625	4.331.010
United Kingdom	13.410.801	1.478.677	551.222.530
British Colonies	782.688	334.115	34.648.670
United States (exclud'g Lakes)	1.220.905	1.259.086	61.439.660
Uruguay	26.488	19.540	1.254.920
Other Countries	40.914	23.149	1.868.050
	26,182,293	6,329,903	$1,110.590.750

Foreign trade in breadstuffs and raw material is governed almost entirely by the natural law of supply and demand; consequently commercial nations are especially anxious to increase their exports of manufactured products, and no class of exports is so favorably affected as these by large foreign investments, intimate financial and banking relations with other countries, and commercial houses established abroad. These agencies are possessed plentifully by the old and great financial nations of Europe, but America is very deficient in them. In later years Germany especially has fully recognized their importance and advantage, and has devoted herself to strengthening greatly her commercial position in these respects.

The following table, however, shows surprising results in view of the advantages for the encouragement of foreign trade in manufactured articles which, it has just been stated, are possessed by Europe. It is equally surprising that the exports of manufactures from the United States in the period 1880-1900 have increased relatively two and one-half times as rapidly as its production of manufactures, which have enjoyed the stimulating effect of a protective tariff.

EXPORTS OF MANUFACTURED ARTICLES BY THE FOUR PRINCIPAL COMMERCIAL NATIONS. 1880—1890—1900.

COMPILED FROM STATISTICS OF BRITISH BOARD OF TRADE AND U. S. TREASURY DEPARTMENT.

Years.	United Kingdom.	United States.	Germany. (Approx.)	France. (Approx.)
1880	$970,681,400	$102,856,015	$415,000,000	$370,000,000
1890	1,118,657,488	151,102,376	535,000,000	400,000,000
1900	1,142,602,562	433,851,756	745,000,000	450,000,000
Increase of 1900 over 1880	176,911,162	330,995,741	330,000,000	80,000,000
Per cent. of increase 1900 over 1880	11.54	321.66	79.52	21.62

EXPORTS AND IMPORTS OF RAW MATERIALS EMPLOYED IN MANUFACTURING BY THE FOUR PRINCIPAL COMMERCIAL NATIONS. 1890—1900.

PREPARED FROM BRITISH PARLIAMENTARY STATISTICS.

IMPORTS.

Years.	United Kingdom.	United States. (Approx.)	Germany.	France.
1890	$752,881,725	$194,000,000	$446,000,000	$468,340,000
1900	878,112,225	280,381,000	700,750,000	757,060,000
Increase	125,230,500	86,381,000	254,750,000	288,720,000
Per cent.	16.6	44.5	54.9	61.7

EXPORTS.

Years.	United Kingdom.	United States. (Approx.)	Germany.	France.
1890	$107,703,260	$350,000,000	$177,500,000	$179,800,000
1900	209,395,000	459,250,000	277,750,000	216,960,000
Increase	101,691,740	109,250,000	100,250,000	37,160,000
Per cent.	94.1	23.8	56.5	20.6

This most remarkable increase of American exports of manufactures shown, is, in my opinion, attributable principally to the working of natural economic laws rather than to extensive efforts toward expanding foreign trade. A glimpse should be given of the position of the four principal commercial nations as regards their position on the furnishing of raw materials for manufacturing purposes; hence the second table on the preceding page.

And now to review some of the differences between European and American conditions in practice.

The personnel of the staffs in the industrial concerns of the various countries in Europe, broadly speaking, may be said to be national for each country; yet industrial and commercial organizations are of necessity planned to secure international trade, for, in the words of Mr. Carnegie, "No one European country has a large homogeneous market."

In America, the reverse is the case in almost every particular. The personnel of the staffs of practically every large American concern is cosmopolitan; there, as nowhere else, are found associated men of many nationalities, possessing different racial characteristics and methods of thinking, widely varying education and experience—yet all working harmoniously for a common purpose, and thus uniting the more important elements essential to best conducting international trade. Nevertheless American organizations, with few exceptions, have paid little attention thereto, but have, quite naturally, devoted their principal efforts to securing business in that large homogeneous home market which is open to them.

The European is not generally an expert in creating a market or demand for new things, but he thoroughly understands the necessity of meeting the requirements of every existing market, and all the peculiarities incident thereto; he constantly does it, in a most admirable manner.

The American is expert in introducing new things and creating a demand therefor, as is evidenced by his success with sewing machines, typewriters, popular cameras, agricultural machinery, etc., abroad; but despite the fact that, as stated, he has at command the personnel, manufacturing methods, and natural resources to best meet the requirements and peculiarities of any market, he is usually inclined to the theory that American practice is right in everything, and that the foreigner can easily be convinced thereof; and he hesitates to furnish exactly what may be required by the foreigner, or to supply it in the manner in which it may be desired. He is surprised that the foreigner is seemingly obstinate in his theories, and forgets that this comes through traditions and familiarity with some certain practice, or that, as is frequently the case, local conditions actually necessitate something at variance with ordinary American practice.

European industrial methods, laid out to meet the requirements of international trade, have hampered standardization, but have developed methods for the economical production of special work. American methods have produced the perfection of standardization, but have operated against the most economical production of special work. A happy combination of economical production on both these classes of work would, of course, be the ideal condition. Owing to his natural versatility. and his possession of the elements which he has at command, it is but natural to conclude that the American will reach this ideal when he is forced to do it through the necessities of trade.

The idea is generally prevalent in Europe that despite America's industrial success, the craftsman is disappearing in the United States. This may be true in those industries where he should disappear because of his former work being better accomplished in other ways; but in those industries where he should continue, America stands at the head of all nations, for she possesses the best talent from all.

In American manufacturing there is unquestionably carelessness in the use of raw materials, because they are generally cheap, while the highest possible efficiency is obtained from labor, because it is dear. In Europe, the reverse is the case. Great economy is manifested in the utilization of raw materials, because they are ordinarily dear, and very low efficiency is secured from labor, because it is cheap.

High efficiency of labor, with its corresponding high rates of wages, naturally increases the home consumption of manufactured products; while the most thorough utilization of power and attendant use of machinery, incident to high rates of labor, does on many articles reduce manufacturing costs to a lower figure than where time rates of labor are less. Conditions in the United States, illustrated by the tables opposite and subsequently compared with similar conditions elsewhere, demonstrate this feature, and illustrate the comparative extent of various markets for manufactured goods.

Complete statistics of similar character are not available for other countries in recent years; but "Mulhall's Industries and Wealth of Nations" 1895, gives most of the essential data up to that period, excepting as regards water power; certain exact figures upon various features involved are also available in recent publications of various Governments, so that reasonably approximate estimates can be made upon these conditions in countries other than the United States, for comparison therewith.

CONDITION OF MANUFACTURES IN THE UNITED STATES.

EMPLOYEES, PRODUCTION, AND POWER.

Census, Years.	Wage Earners.	Value of Products.	Value of Products per Wage Earner.	Product per Capita Population.	Total H. P. Used in Manufacturing.	H. P. per Wage Earner.
1880	2,732,595	$5,369,579,191	$1,946	$107	3,410,837	1.21
1890	4,251,613	9,372,437,283	2,204	150	5,954,655	1.40
1900	5,308,406	13,004,400,143	2,450	170	11,300,081	2.15

CONSUMPTION OF MANUFACTURES.

Years.	Exports.	Imports.	Total Manufactures Consumed in U. S.	Consumption per Capita Population.
1880	$102,856,015	$268,333,432	$5,535,056,608	$110
1890	151,102,370	346,678,654	9,568,013,561	150
1900	433,851,756	315,060,916	12,885,609,303	169

It should be borne in mind, however, that the comparative number of artisans, or hand laborers, is much larger in European countries than in the United States, and that all such, with their products, are included in European statistics; but as it is not entirely so in the United States reports, the basis of comparison is not quite the same. The total of manufactures shown for European countries is proportionately higher than had the same rule been followed in computing them as in the United States, but the output and power used per wage earner are reduced under European practice in this respect. The effect of this is perhaps best illustrated by stating that in the United Kingdom, in 1900, there were approximately 4,000,000 people employed in workshops and factories, yet the total of those engaged in manufactures, including artisans, was not far from 9,000,000. If the power used in manufacturing were computed on only those employed in workshops and factories, it would average 3/4 of a horse power each, instead of 1/3 as in the table on the following page.

In Switzerland, in 1900, there were only 242,534 employed in factories, and 52,291 engaged in manufacturing at their homes; yet the total given in the table, including artisans employed in manufacturing, is 600,000.

Another feature which should be borne in mind is that the nature of a country's manufactured products and the prices prevailing thereon, may greatly affect their total or per capita output.

Despite the greater use of power and machinery in the United States as shown by the following tables, the proportionate manufacturing investment, strange to say, i. e., land, buildings, and machinery,

APPROXIMATE CONDITIONS OF MANUFACTURES IN VARIOUS COUNTRIES OF THE WORLD IN THE YEAR 1900.

EMPLOYEES, PRODUCTION AND POWER.

Countries.	No. of Wage Earners.	Value of Manufactures.	Value of Products per Wage Earner.	Per Capita Population.	Total H. P. Used in Manufactures.	H. P. per Wage Earner.
United States	5,308,406	$13,004,400,143	$2,450	$170	11,300,081	2.15
United Kingdom	9,000,000	5,000,000,000	556	122	3,000,000	0.33
Germany	10,000,000	4,600,000,000	460	80	3,400,000	0.34
France	5,000,000	3,450,000,000	690	90	1,500,000	0.30
Belgium	1,550,000	720,000,000	480	110	630,000	0.42
Switzerland	600,000	300,000,000	500	106	320,431	0.54
Austria-Hungary	4,700,000	2,000,000,000	425	44	750,000	0.16
Russia	4,500,000	1,980,000,000	440	15	700,000	0.15
Italy	3,600,000	1,700,000,000	472	53	900,000	0.25
Norway	200,000	90,000,000	450	41	80,000	0.4
Sweden	490,000	280,000,000	572	56	200,000	0.41
Holland	460,000	245,000,000	540	49	130,000	0.29
Spain	1,800,000	650,000,000	361	38	250,000	0.15
Australia	550,000	500,000,000	900	90	460,000	0.80
Japan (Factories only)	388,298	220,000,000	566	5	84,816	0.22
Canada	550,000	800,000,000	1,455	146	750,000	1.36

as contrasted with the output of manufactures, is about the same as in France, Belgium and Switzerland; viz., a manufacturing investment equal to about one-third of the total annual production. In Germany it is believed that practically the same condition prevails, while in the United Kingdom the proportionate factory investment is considerably higher.

While the separation of manufactured articles produced in factories from those produced by artisans in Europe is an impossibility, it is believed that the average production per wage earner in the factories there is about 40 per cent. of the similar production in the United States, or say $980 per annum; and it is a liberal estimate to consider that one horse power is used per wage earner in European factories.

Considering the average annual compensation of the wage earner in European factories $170, which is one-half that paid in the United States, the figures

CONSUMPTION OF MANUFACTURES.

COUNTRIES.	POPULATION.	TOTAL MANUFACTURES CONSUMED.	APPROXIMATE CONSUMPTION PER CAPITA POPULATION.
United States	76,149,386	$12,885,609,303	$169
United Kingdom	41,000,000	4,273,397,438	104
Germany	56,367,000	4,152,450,000	74
France	38,700,000	3,168,000,000	82
Belgium	6,700,000	660,000,000	98
Switzerland	3,300,000	243,500,000	74
Austria-Hungary	45,405,267	1,900,000,000	42
Russia	128,900,000	2,000,000,000	16
Italy	32,100,000	1,714,000,000	53
Norway	2,200,000	115,000,000	52
Sweden	5,000,000	260,000,000	52
Holland	5,100,000	269,000,000	53
Spain	19,000,000	730,000,000	43
Australia	3,700,000	605,000,000	162
Japan	45,000,000	230,000,000	5
Canada	4,800,000	880,000,000	183

there being $340; and considering the average cost of generating power about $40 per annum on each continent, it is seen that in European factories the average percentage for labor and power on total cost of production is 21.4 per cent. In the United States it is 17.4 per cent. In view of this and of the well-known advantages possessed by the United States on nearly all classes of raw materials, no further arguments are considered necessary to demonstrate its strong position as a manufacturing nation, and its ability to compete for the world's trade on manufactured products.

The above tables also show conclusively that America itself is by far the best market of the world for manufactured products; consequently it is not strange that up to the present American manufacturers should have devoted their principal attention to home trade. Their success in foreign markets, so far, is attributable principally to their natural advantages already stated, and to the energy and ability of their representatives abroad.

When American manufacturers devote especial attention to meeting the requirements of each foreign nation; when the American ocean carrying trade is re-established; when American commercial houses exist everywhere; when America's growing wealth is more largely invested abroad; and when the country participates more thoroughly in international banking—then the amount of America's foreign trade will be more extensive than that of all Europe combined.

WAGE-PAYING METHODS. FROM THE VIEW-POINT OF THE EMPLOYER.

By Henry Hess.

The question of the choice and adoption of a wage system is one of the most important in modern shop management. Mr. Hess's method of studying it goes to the foundations of the subject and takes account of all the elements entering the problem; at the same time it is thoroughly practical, in that it is addressed to working conditions and presented in graphic form, making the results instantly and clearly apparent. The paper is the second of three, taking up the advantages of the advanced wage systems from the viewpoint of the workman, the employer, and the invested capital.—The Editors.

IN a previous paper, published in this Magazine for April, 1904, page 27, various methods of wage payment were considered from the workman's standpoint; it was assumed that, on the whole, the workman was inclined to render a fair equivalent in work for a fair payment, and that he would be stimulated to a fuller exercise of his powers of mind and muscle by a permanently assured increase of payment for his time. The feeling that such higher payments might be only temporarily granted by the employer, while the larger amount of work accomplished under its stimulus would be permanently exacted, was recognized as undeniably existent. The author's experience as a workman, manager, and employer has by no means shaken his belief that this attitude and the justification for it are not final; but its existence frequently proves pernicious in engendering a feeling of distrust and causing the adoption of safeguards that are only too often of a highly irritating nature. The final conclusion was reached that mutual self-interest might safely be relied on to bring about a unification along those lines that could be shown to be most clearly to the advantage of employer and employed; in other words, that system of wage payment that would result in the greatest return for his time to the workman, and the greatest profit on his product to the employer, would be certain of forcing itself to the fore, to the ultimate general welfare.

It is not lost sight of that the method of wage payment is but one incident in industrial production, as many other factors largely affect the costs; but as these all manifest themselves finally, so far as the relations between capital and labor are concerned, in the payment made to labor, that payment is the crucial element.

The various wage-paying methods considered are the old established day and piece plans, the Halsey premium plans and the Rowan modification, and finally the Gantt bonus system. In the first paper these were compared as to their relative value to the workman in amount of pay for his time when exerting himself to save time on the individual job or task. Chart 2 is reproduced on page 174 in graphic illustration of such values. Leaving out of consideration such psychologic elements as the fear that too great a wage would tempt the employer to a reduction, it was shown that, as regarded the wage rate per hour, for savings up to one-half time the Gantt bonus gave the highest return, and after that the ordinary piece work; at savings beyond one-half time these two changed places: next in order came the various premium plans with the Rowan modification in the lead, but caught up with and then passed by the Halsey 50 per cent. premium at one-half-time saving. Returns to the workman were least under day pay. For the poorer workman unable to save time, or actually taking more than that allowed, the earnings under all but the piece plan were alike and constant, while the latter penalized time losses by decreasing the hourly wage rate; this characteristic accounts for part of the disfavor with which piece work is viewed in most industries, notwithstanding the fact that it is of more universal application in the trades in general than any other method of payment.

Throughout this consideration, for want of a universally applicable norm, a wage-earning capacity of 25 cents per hour under day pay has been taken; the return in wages per hour has been assumed as equal for all methods in the base time of one hour allowed. In practice, piece-work rates are frequently established at an initial cut from the rate under day pay, in which case the returns would be relatively less than here shown; on the other hand, the introduction of the premium plan is often accompanied by an increase in the time allowance, the effect of which is a raising of the value to the workman above that shown. A certain study of the time required for day work is also often made use of in fixing the base time in piece and premium work; so far as the actual work of the machines themselves is concerned, this is often fairly correct. Mr. Taylor was the first to study systematically the possibilities along this entire line and he finds that much shorter times than are usually considered possible could be realized without undue exertion. In order to provide the necessary stimulus for turning out the much larger amount of work, Mr. Gantt starts in with a large bonus for the attainment of the time set, resulting in a decidedly higher wage return per hour.

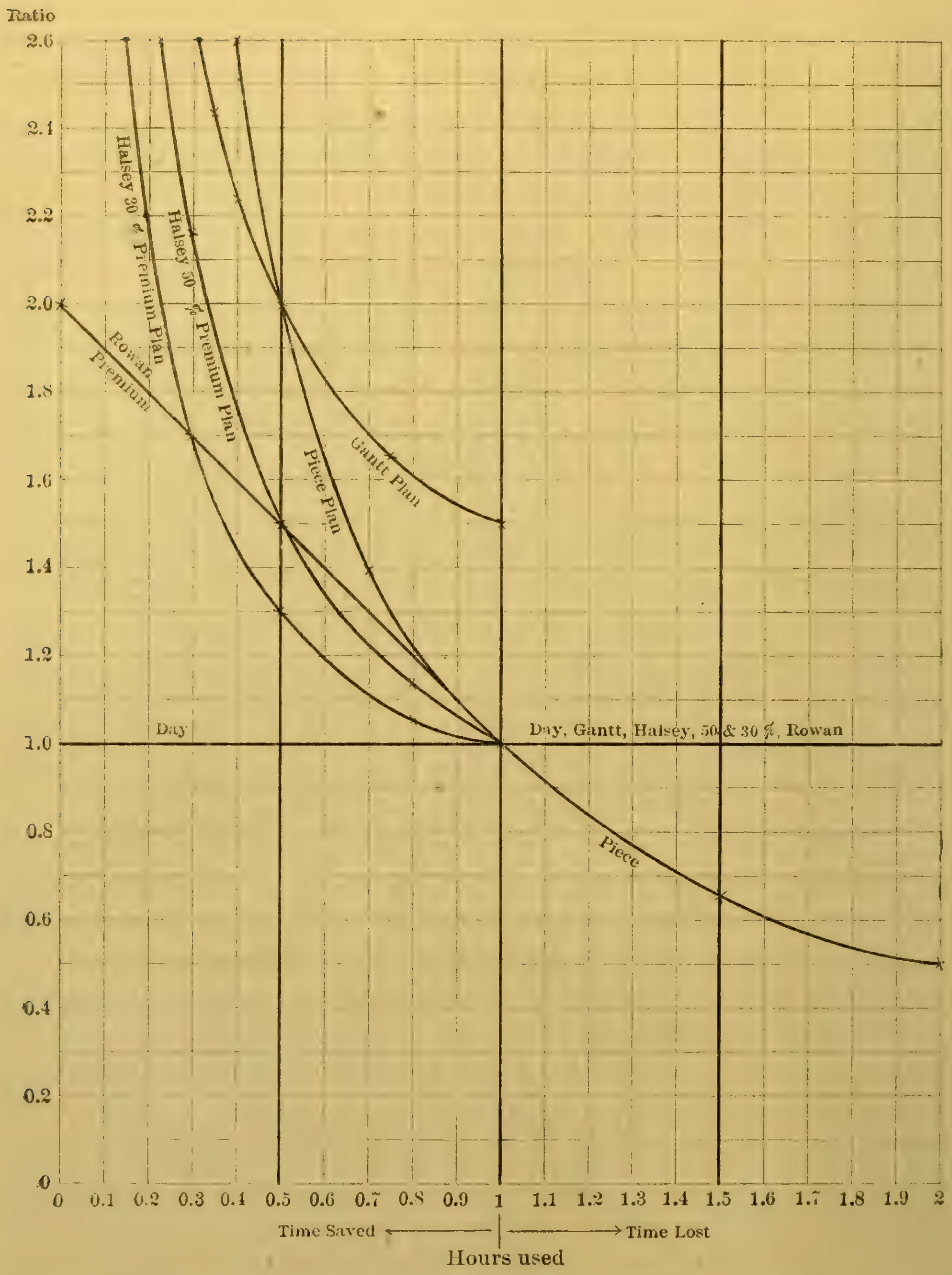

CHART 2. RELATIVE VALUE TO THE WORKMAN OF VARIOUS METHODS OF WAGE PAYMENT, AS COMPARED WITH DAY PAY.

The horizontal scale shows the hours used, with one hour as the time set as a basis in the center of the scale and shown by a solid vertical line; time saved and lost lie to the left and right of this; the region of most likely results, that is time savings and losses of one-half, are included between the outer heavy lines; the vertical scale at the left gives the relative values as ratios to day pay as unity.

In the following consideration the objective of the manager is considered to be the attainment of the highest profit as compared with

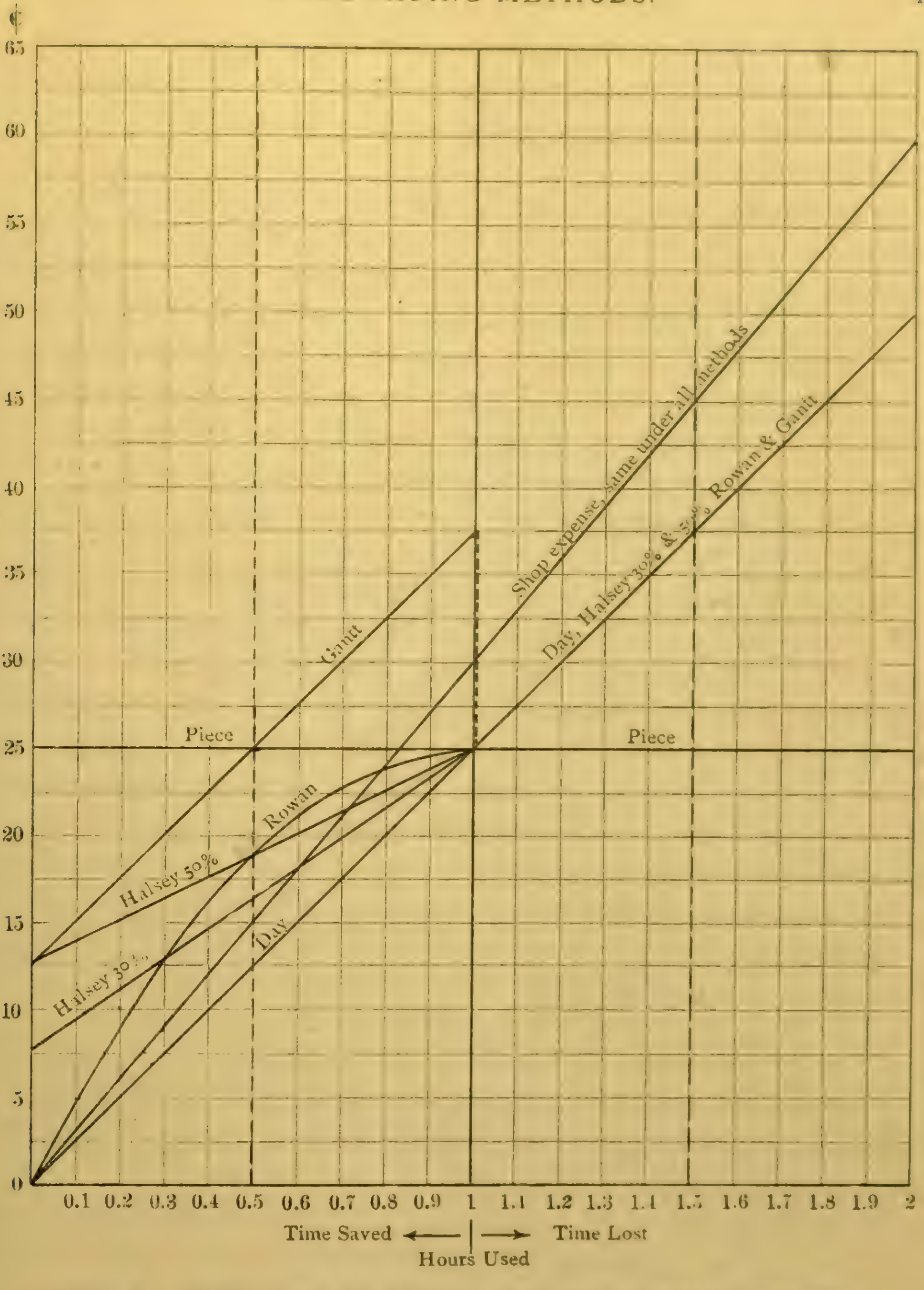

CHART 3. WAGES COST BY VARIOUS METHODS OF WAGE PAYMENT.

his total costs. The various elements affecting this are compared first singly and then collectively; their characteristics are illustrated as curves and lines referred to the hours used, in the same way as previously explained for Chart 2, to show what influence time savings and losses by the workmen exert on the various costs, and finally on the profits. The base line of all the charts is therefore the same.

Chart 3 refers to wage costs, and shows these to be constant for piece work whether time be saved or lost; all of the other plans are characterized by a decrease of wage costs with time savings and an increase attending time losses. When time is lost the piece plan shows the lowest wage cost.

Mr. Gantt's bonus plan and the piece plan give the highest wage costs when time is saved; were the assumption true that the wage cost alone correctly measures the value of the various plans, then the later systems, as well as the piece plan, would all be inferior to day work, as that shows the lowest wage cost. This is, in fact, a contention upheld by not a few. It is not surprising that those who compute costs on this basis see the chief possibility toward cost reduction in lowering the hourly wage rate; the great majority of workmen are so accustomed to hearing the expenses based directly on the wages, that they must logically come to the conclusion that any attempt at cost reduction necessarily involves a reduction in their hourly earnings. But aside from wage-cost, time is an element that has a direct money value in manufacturing operations; that value is variously recognized as "shop expense, burden, oncost," etc.; though frequently considered as directly proportional to the wage cost, particularly so by the older school of accountants, the closer study of latter years has shown it to be very nearly proportional to the time occupied. Were the first consideration correct, then it would confirm the wage cost as the correct measure of the value of any wage-paying plan.

The fact that shop expense is an element dependent upon time, and not properly chargeable as a direct ratio of the wage cost, is now so generally recognized that all argument in proof may be here dispensed with and only its influence in the concrete be considered. Shop expense in well managed machine shops will rarely exceed 30 cents per hour; the diagonal in the chart marked "expense" is characteristic of its influence with varying amounts of time.

Chart 4 gives the sum of wages cost *plus* expense in direct amounts under the various methods of wage payment, and shows that so long as the base time is not exceeded the advantage lies with day pay, with the Halsey 30-per cent. premium plan a close second; the Halsey 50-per cent. and Rowan premium plans come next in order, the Rowan changing places with the Halsey 50-per cent. at and beyond time savings of one-half, and with the Halsey 30-per cent. as soon as less than 0.3 time is used; it finally coincides with the results of day pay when all the time is saved. It takes time savings of fully one half to make the Gantt plan cost no more than piece work, and still greater savings to give it an advantage over that. It is obvious that the

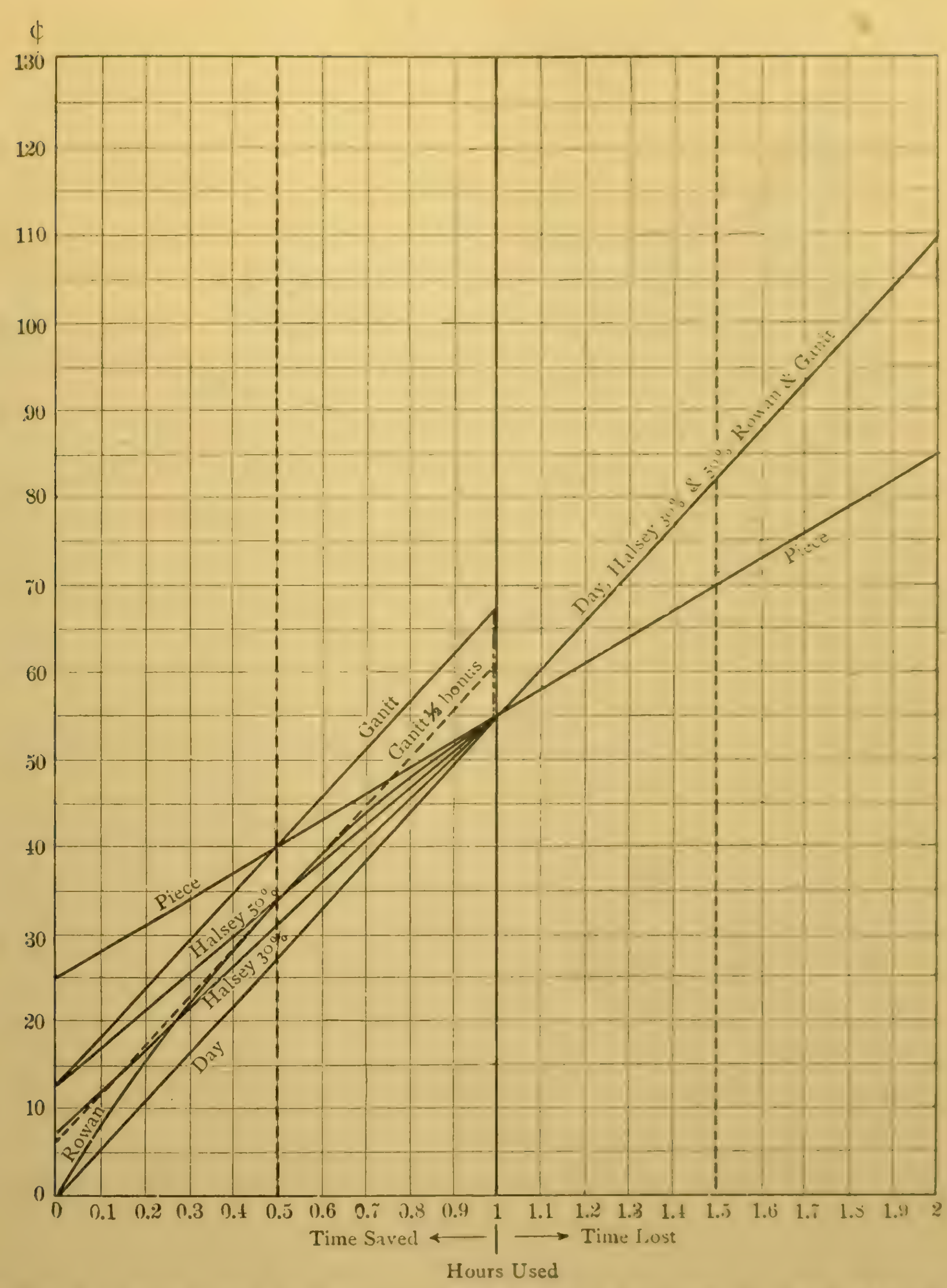

CHART 4. WAGES COST PLUS EXPENSE BY VARIOUS METHODS OF WAGE PAYMENT.

bonus of the Gantt plan is too high; were that reduced by one-half, it would better the total cost as compared with the Halsey 50-per cent., but not before a time saving of over one-half was made; it would then better the results of piece work at a time saving of over one-fourth; the corresponding line is dotted in on the chart. If no time is saved, the advantage lies with piece work as against all of the other plans, which are then of equal value as among themselves.

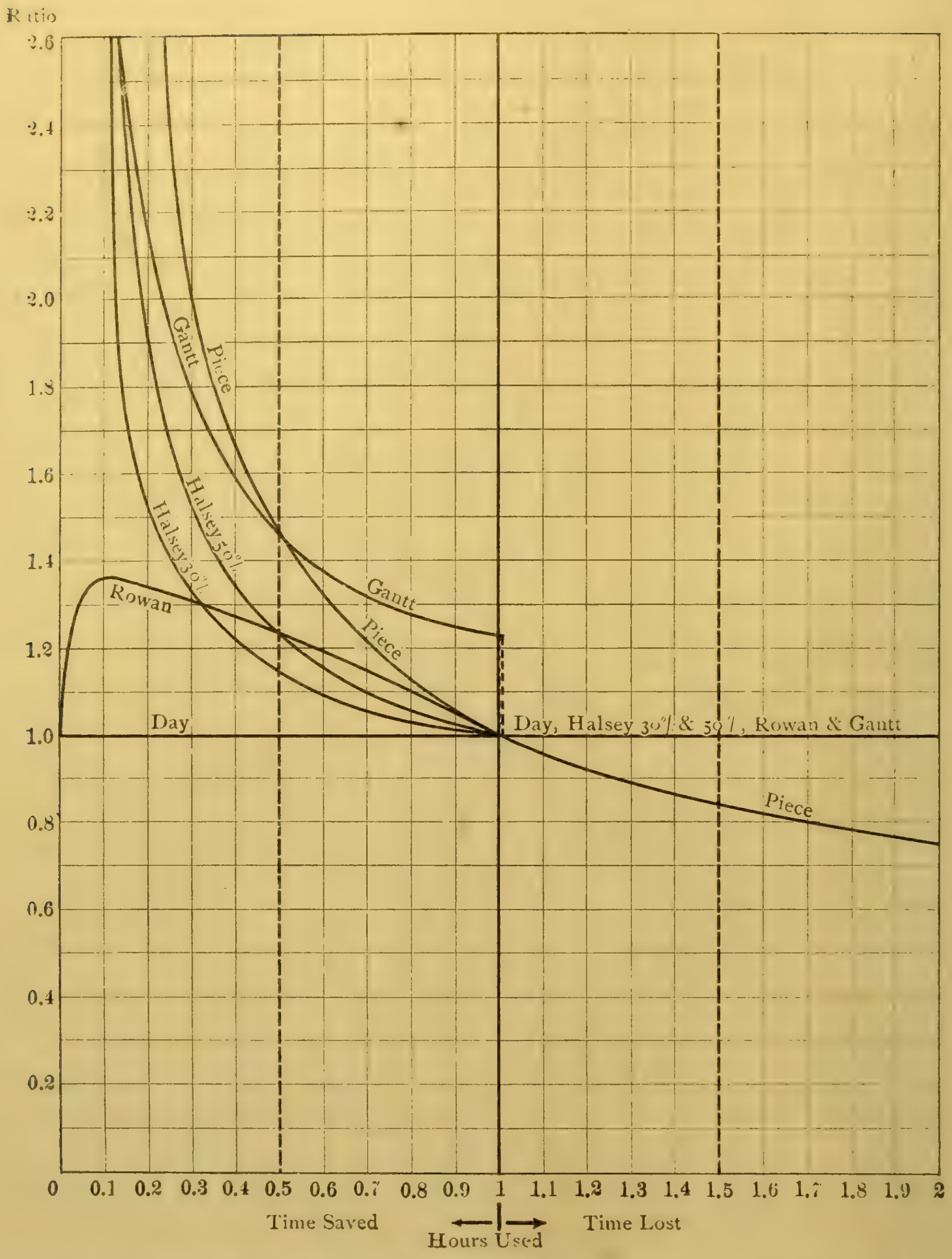

CHART 5. RELATIVE WAGES COST PLUS EXPENSE BY VARIOUS METHODS OF WAGE PAYMENT, COMPARED WITH DAY PAY.

The relative value of the various plans is shown still more clearly by a consideration of their ratios; Chart 5 illustrates this with day pay taken as unity. It shows absolutely that day pay gives the lowest cost whenever time is saved. Within the region of reasonably-to-be-expected time savings, up to one-half, the Halsey at 30 per cent. most nearly approaches it. The logical conclusion is that to keep down wage cost *plus* expense total, day pay should be employed, provided that under it the men can be induced to put forth nearly equal efforts towards saving time. If a stimulus in the direction of increased earnings for increased effort is needed, the Halsey 30-per cent. and after that the Halsey 50-per cent. and the Rowan premium plans deserve consideration. The advantage possessed by the piece plan in giving the lowest total costs when time is lost may be disregarded; no adequate management will permit the condition of time losses often enough to allow it to count as a material factor.

The works manager's or employer's interest does not, however, cease when he has brought his wages cost *plus* expense down as low as possible; at least, not if he is interested in sales and profits. The cost of material must be added to wages and expense to get the total cost. It is assumed that selling expense is included in the shop expense, or that such part as is not so included is added directly to the selling price; this consideration was influential in setting the expense at the rather high rate of 30 cents per hour.

It is clear that the material cost will be constant, and independent of the variation in wage and expense cost due to time savings or losses; assuming it at 40 cents in industries having a day-pay rate of 25 cents per hour will answer fairly well. Chart 6 represents the conditions under day pay. It contains diagonal lines giving wages cost and expense cost, a horizontal line giving the material cost, and a diagonal line giving the total cost; this latter is made up directly from the summation of the cost elements mentioned. The selling price will most likely be fixed by competitive market conditions at, say, 100 cents, and will of course then be constant, independent of the gain or loss in time from the base time allowed for the work; a corresponding horizontal line is entered in the chart. So long as that line is above the diagonal representing total cost, a profit is realized; when the total costs rise above, a loss is recorded. In this particular instance, the change from profit to loss is made when, instead of the base time allowed of 1 hour, 1.1 hours are actually used—a rather close margin unless there is a certainty of time savings being made. In order to emphasize this, the area between the selling price and total cost lines is shaded, throwing the profit and loss regions more distinctly into relief. The curved lines on the chart show the profit and loss figured out as a percentage of the total costs.

The line representing the actual wages rate per hour to the workman is also inserted, in order to complete the presentation on one chart of all of the various elements of the problem. Charts 7, 8, 9, 10 and

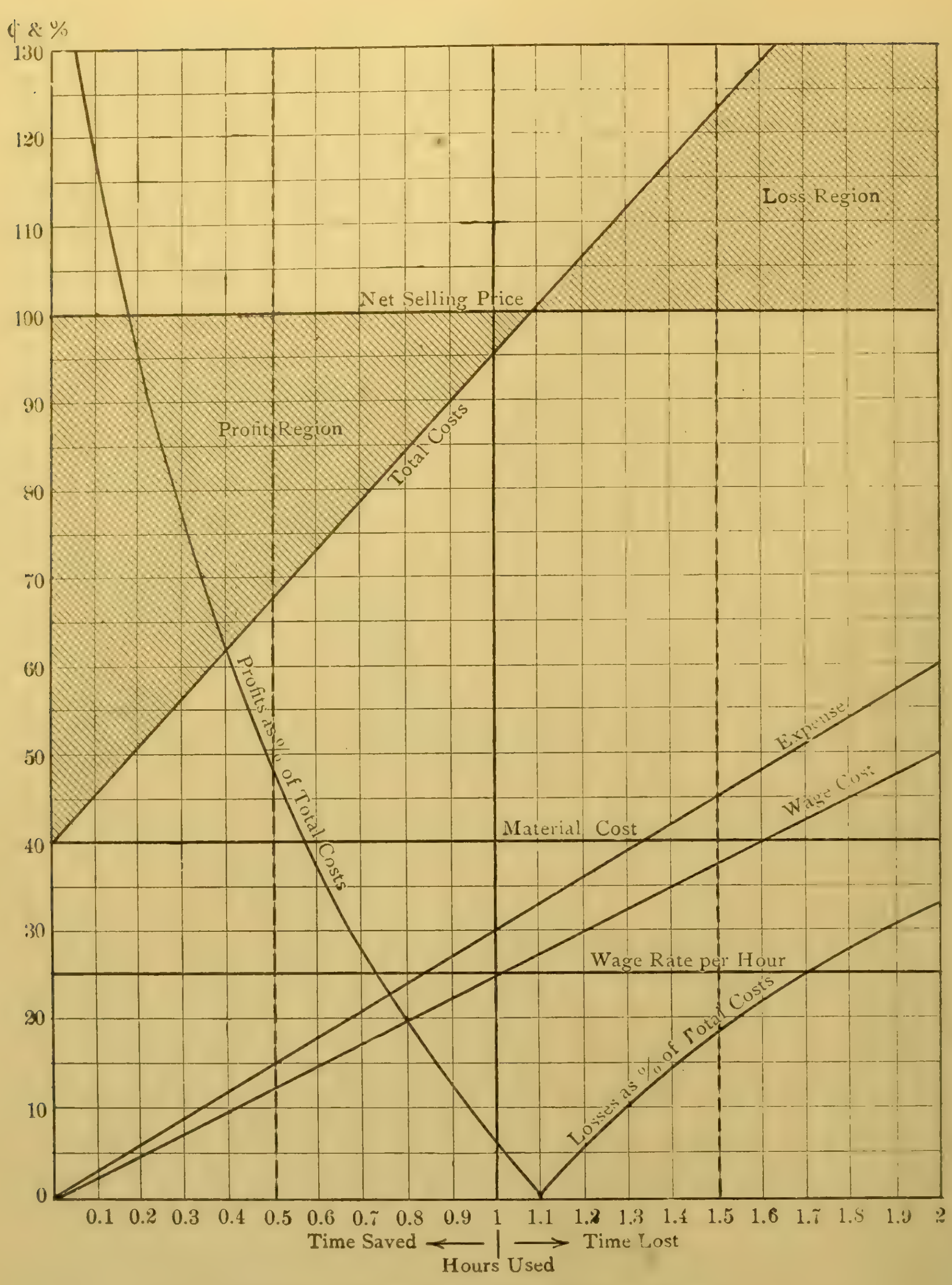

CHART 6. PROFIT AND LOSS BY DAY PAY.

11 are of the same character and relate to the Halsey 30-per cent. and 50-per cent. and the Rowan premium plans, the piece-work system, and the Gantt bonus method. It is evident that that plan is best that shows the largest profit area within the reasonably-to-be-expected time savings up to one-half. Such comparison will show the advantage to lie in the order in which the charts follow, day pay leading.

Piece work, Chart, 10, has a slight advantage under time losses

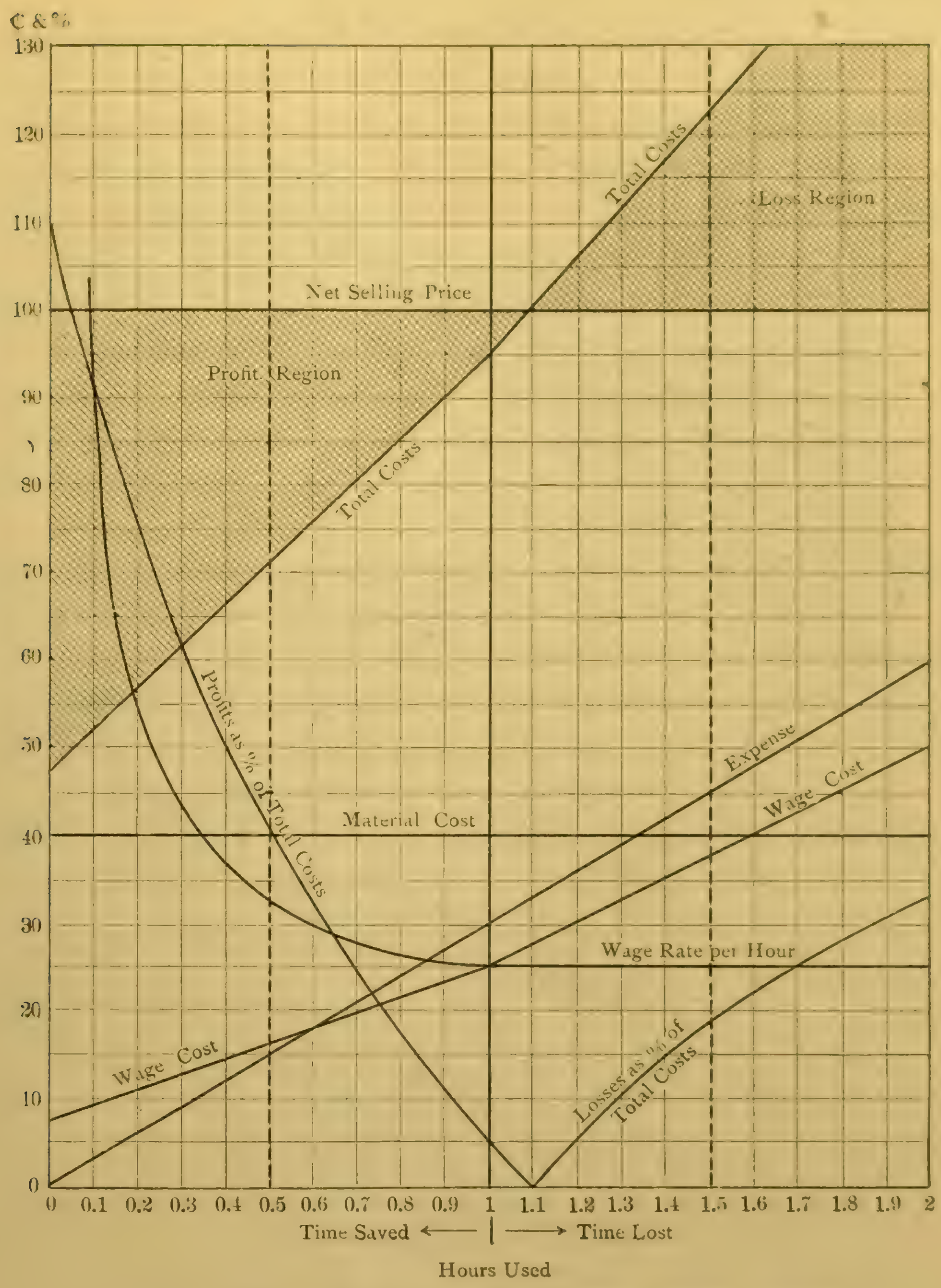

CHART 7. PROFIT AND LOSS BY HALSEY 30-PER CENT. PREMIUM.

in that the crossing of the total cost and selling lines occurs at a somewhat larger time loss—i. e., when 1.17 hours are occupied, in place of 1.1 as with all other plans except the Gantt. A comparison of the loss areas also shows that for piece work to be decidedly the smaller, but the difference is not sufficiently great to compensate for the advantages of the other methods on the time-savings side. The existence of such a difference, however, leads logically to the con-

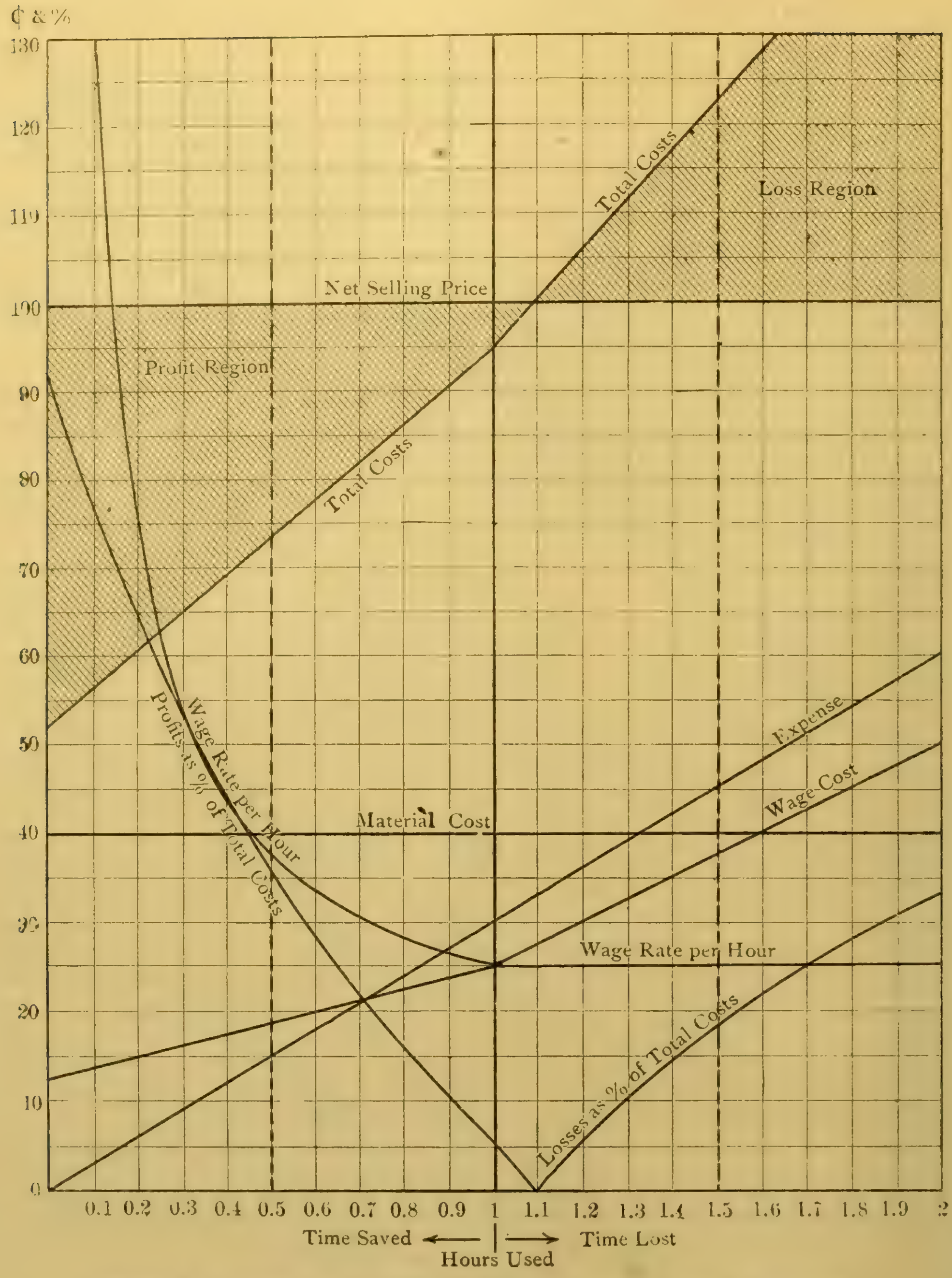

CHART 8. PROFIT AND LOSS BY HALSEY 50-PER CENT. PREMIUM.

sideration of the advisability of adopting a fixed price for the piece in case time is lost, combined with, say, the Halsey 30-per cent. premium plan for time savings, provided such proposal does not meet with too strenuous objections from the workmen. As it should be the aim of good management to make time losses average very few, much stress is not to be laid on this phase of the situation.

Chart 11 of the Gantt plan shows a loss beginning in the region of time savings at 0.87 hour, emphasizing still further the conclusion already arrived at—that it is inadvisable to provide too high a bonus. The effect of the sudden change from such a high bonus to the day rate when no time is saved, manifests itself somewhat paradoxically in reintroducing a short region of profit between time used of 1 and 1.1 hours, so that unless sufficient time is saved to occupy only 0.87 hour it is better to lose time to the extent of taking up 1.1 hours.

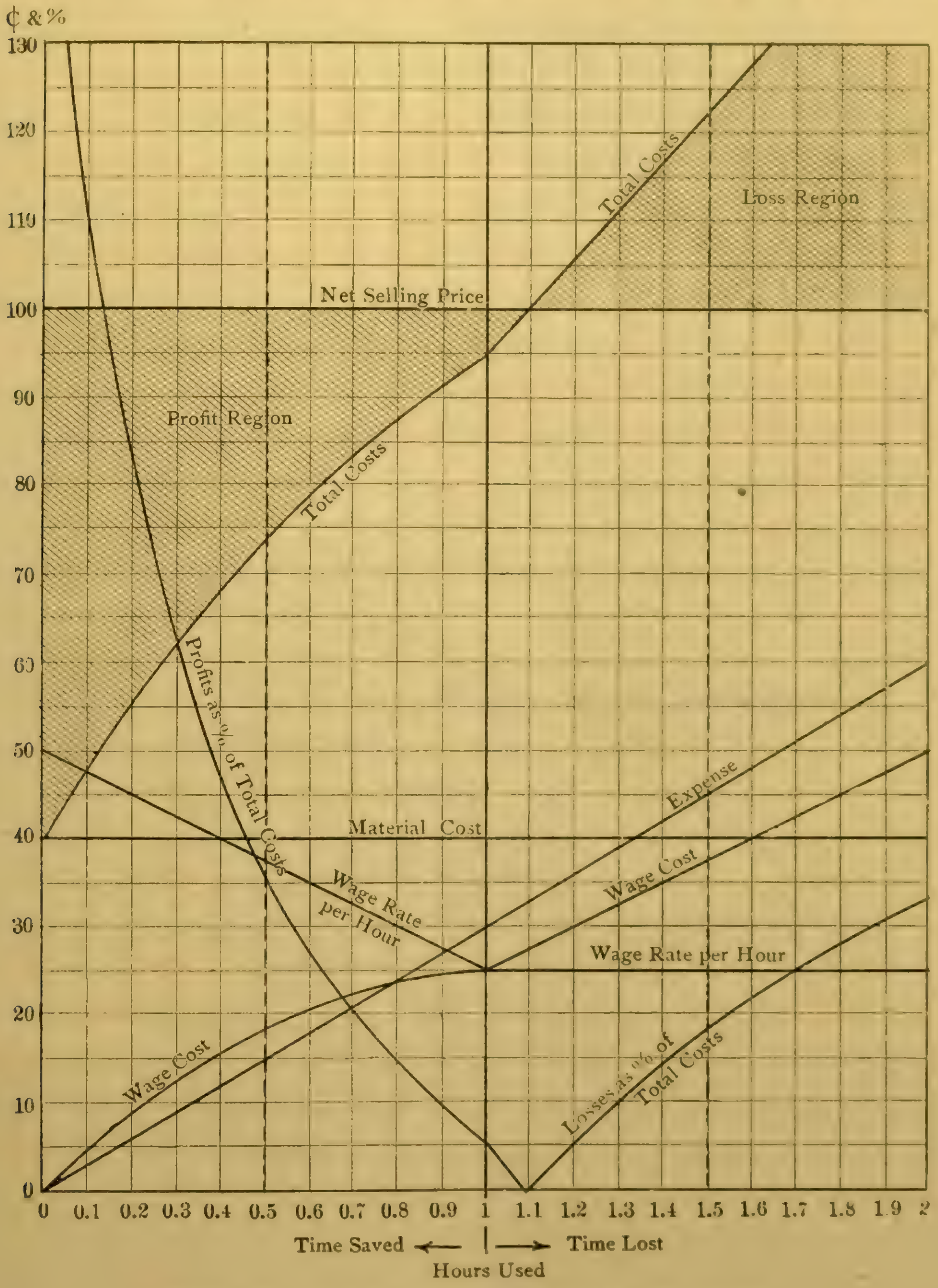

CHART 9. PROFIT AND LOSS BY ROWAN PREMIUM.

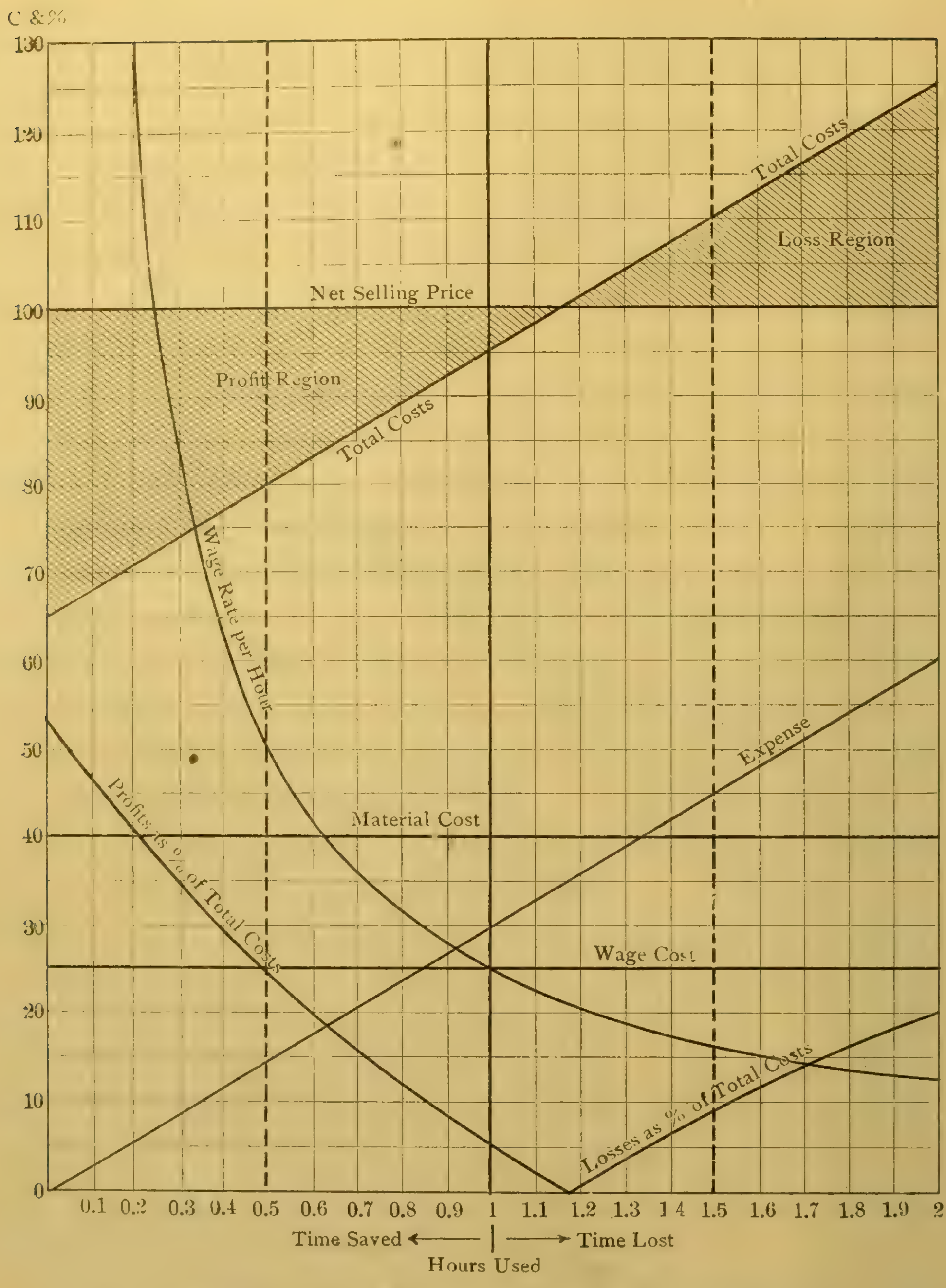

CHART 10. PROFIT AND LOSS BY PIECE WORK.

The relative values of the various plans as influencing the profits are still more clearly shown on Chart 12; data taken from the curves that give the profits as a percentage of the total costs on Charts 6 to 11 are plotted as ratios to the percentage of profits by day pay as unity. With only 0.8 hour of the base time occupied, the values are as 1 for day pay, 0.91 for Halsey 30-per cent., 0.85 for Halsey 50-per cent., 0.82 for Rowan, 0.66 for piece work, and 0.20 for Gantt. Crossings

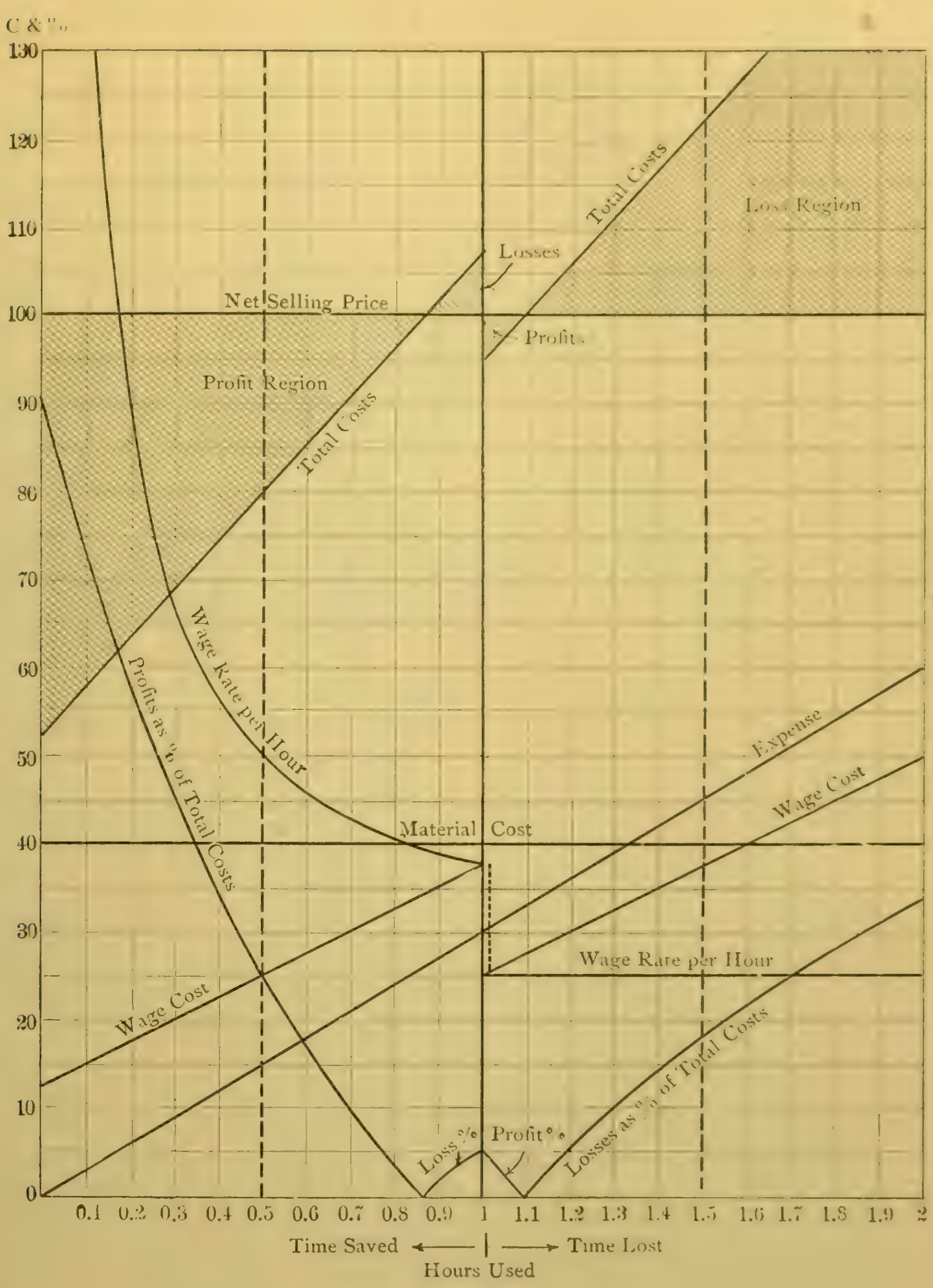

CHART II. PROFIT AND LOSS BY GANTT BONUS.

of the curves indicate equality of the methods at certain time savings; for instance, with 0.3 hour occupied, the Rowan and Halsey 30-per cent. premium plan are of equal value.

The results in profits will naturally vary with the cost of shop expense and material as compared with the basic labor value, and so necessitate a careful consideration of these various elements before arriving at a definite conclusion as to the method of wage apportion-

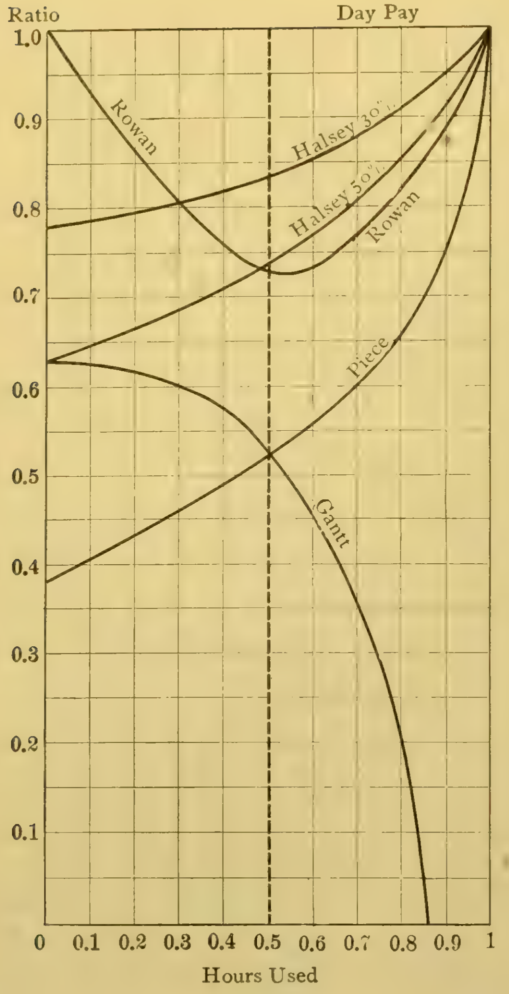

CHART 12. RELATIVE PROFITS BY TIME SAVING UNDER VARIOUS METHODS OF WAGE PAYMENT, COMPARED WITH DAY PAY.

ment to be adopted. Under conditions similar to those here assumed, which may be taken as fairly representative of a large line of machine industries, the general conclusion to be drawn is that profits will be best under day pay, even when under that method not quite as large time savings can be brought about as under the others. Next in order is the Halsey 30-per cent. premium plan; the stimulus it provides is probably sufficient wherever such saving is mainly a question of harder machine driving. In industries in which the output is chiefly dependent upon machinery, day pay is to be advocated as resulting in higher profits, providing that the attendants do not hold the machines down much below their maximum capacity. If that is to be expected—and with the prevalent attitude of organized labor it usually is—the premium plan is again the better, and has also the advantage of acceptance by some unions and the sympathetic approval of others. Piece work is distasteful to labor, and for the manager lies under the disadvantage of giving relatively low profit returns, as shown on Chart 12. The Gantt bonus method with the high bonus advocated gives entirely too poor returns in profits;* reducing the bonus betters the plan in this respect until with the bonus equal zero it is merged in and identical with the day-pay plan.

The effect of these various wage-paying methods from the viewpoint of the investor, as affecting the total capital employed and the interest returns on it, will be considered in the concluding article.

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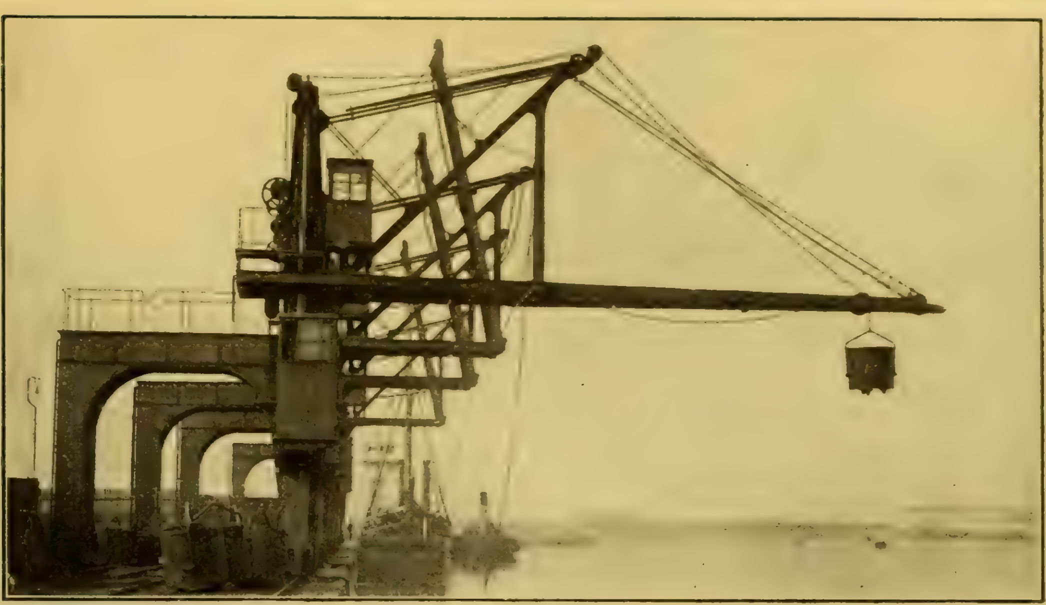
* It is true that its advocates use it only in conjunction with certain highly developed methods of intensifying output; but the favorable returns are then rather to the credit of such methods; even then, with a bonus of 50 per cent. of the day pay, the profits have the value of the Halsey 50-per cent. plan, and only when no time at all is taken, as shown by the coincidence of the Gantt and Halsey 50-per cent. curves at that time on Chart 12.



HYDRAULIC WEIGHING CRANE, FOR DISCHARGING CARGO OVERSIDE OR INTO TRUCKS

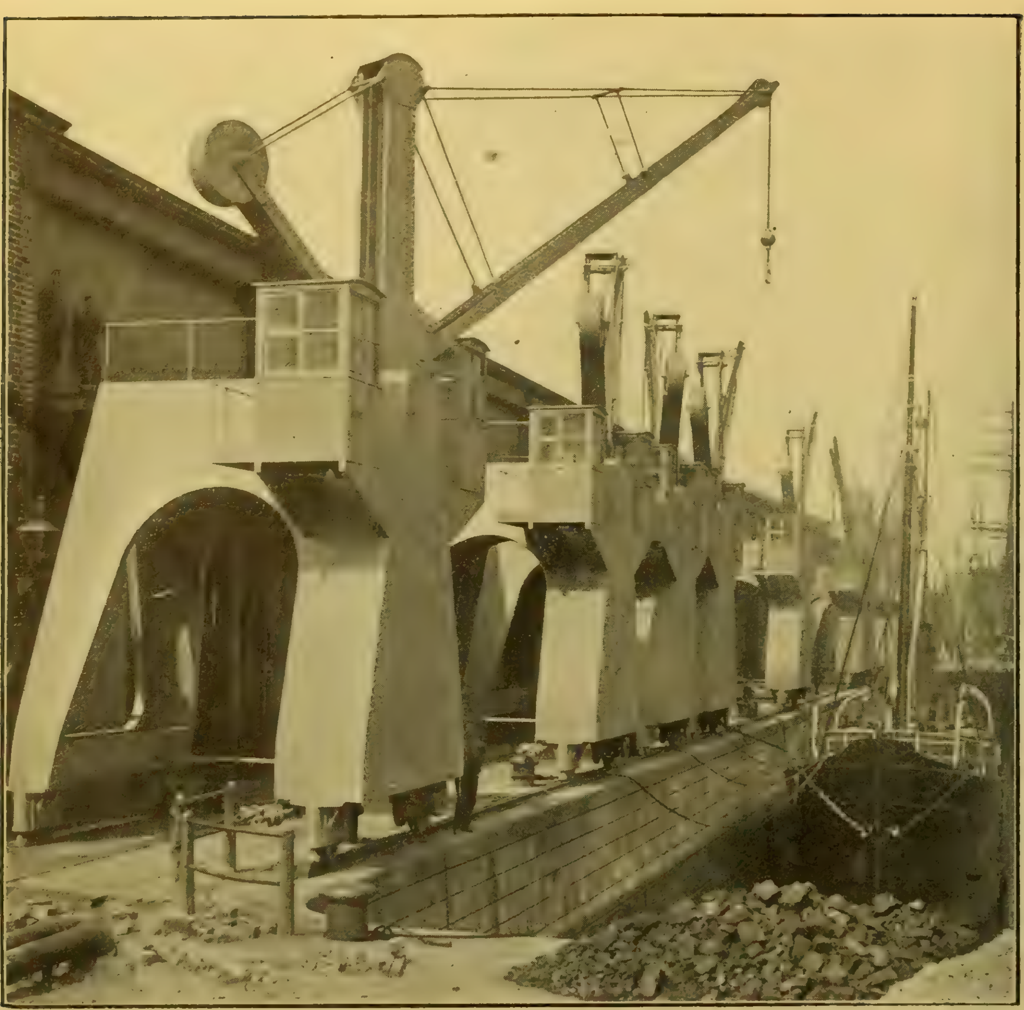
Sir W. G. Armstrong, Whitworth & Co.

HYDRAULIC CRANES AND WHARF MACHINERY.

By George H. Baxter.

Mr. Baxter's review began in the special Labor-Saving Number of THE ENGINEERING MAGAZINE, published in March last. The extent of the subject and the illustration, even in this specialized field of hydraulic power applications, limited it there to coaling machinery. The present article takes up the allied subject of cranes and other wharf machinery.—THE EDITORS.

HYDRAULIC wharf cranes for dealing with ore and general cargo are almost entirely worked by rams and multiplying pulleys, both for hoisting and turning. They vary much in design to suit special circumstances, and are arranged sometimes on the quay, or sometimes on the roofs and walls of warehouses, and they may be either fixed or movable, with fixed or luffing jibs. Many steamships are also provided with cranes worked by hydraulic power. The illustration on the next page shows a row of nine 35-hundredweight movable "portal" cranes made by Fullarton, Hodgart & Barclay, Ltd., Paisley, for the Princes Dock in 1894 for handling general cargo. The pedestal is formed to admit of wagons and locomotives passing underneath and contains the hoisting and slewing cylinders. They have a lifting range of 65 feet, the jib-head pulley being 41 feet above the quay. The rake is 29½ feet and the hook projects 27½ feet beyond the face of the

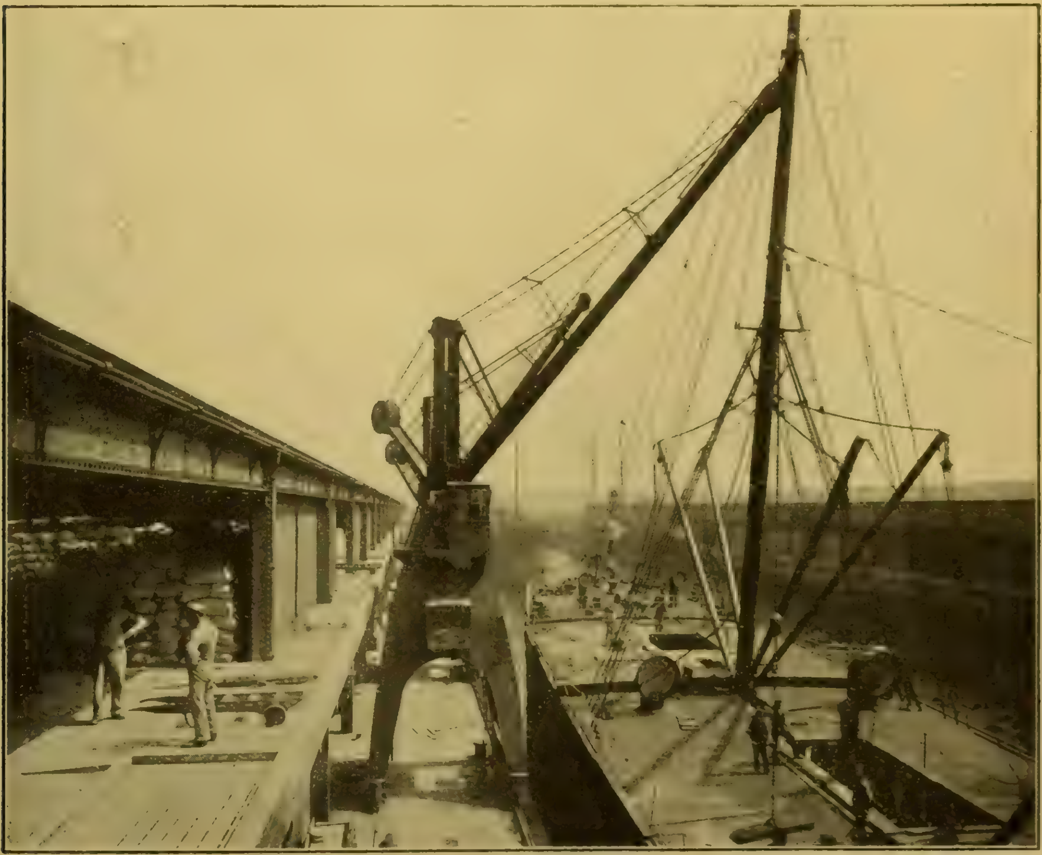


A ROW OF 35-HUNDREDWEIGHT MOVABLE PORTAL CRANES, PRINCES DOCK, GLASGOW.

quay. Hand gear is provided on each crane for travelling it along the quay, although more frequently capstans having a pulling stress of over one ton are used for this purpose. The illustration on the opposite page shows a 2-ton crane of somewhat similar type, giving also a view of the interior of one of the large double-floor sheds on the quays at Princes Dock. These cranes, of which there are eight, are by the same makers, but of larger dimensions, the range of lift being 75 feet, while the jib-head pulley is 60 feet above quay level, and the rake is 41 feet to meet the requirements of larger vessels.

There are a large number of "compound" or double-power hydraulic cranes having the same range, rake, and height as the 2-ton cranes but constructed with a ram capable of lifting loads of 5 tons. A smaller ram slides inside the 5-ton ram, which has a stuffing box at the upper end, and is adapted to lift loads of 2 tons in cranes used for general cargo, and 3 tons in cranes for discharging ore. When the smaller ram, which carries the crosshead with multiplying pulleys, is used, the large ram is held down by stoppers which are removed when the 5-ton ram is required. The heavier lift is provided to avoid the necessity of having to move a vessel to another crane in case of having to deal with any pieces over 2 or 3 and up to 5 tons.

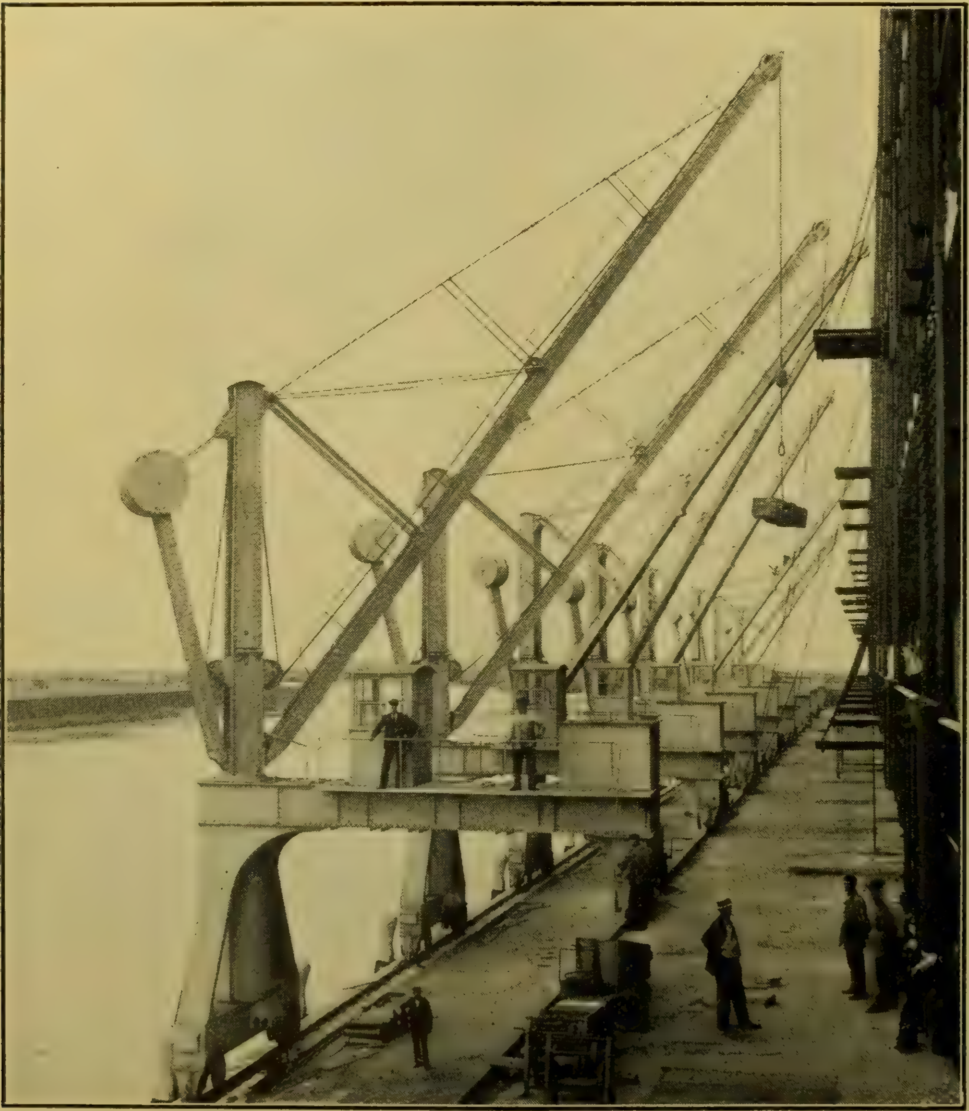
Another type of movable crane, triple-power, is shown in the photograph on page 190. In this crane the vertical leg of the pedestal rests on rails at the edge of the quay, and the back of the horizontal portion on rails at the edge of a balcony or gangway next the wall of the warehouse and level with the first floor. This crane is made to lift loads of 15 hundred weight and 30 hundred weight respectively to a height of 90 feet, and from a pulley half-way up the jib, with a gin block giving a double purchase, can lift 3 tons 45 feet at a reduced speed.



TWO-TON MOVABLE HYDRAULIC DOCK CRANE, PRINCES DOCK, GLASGOW.
Fullarton, Hodgart & Barclay, Ltd.

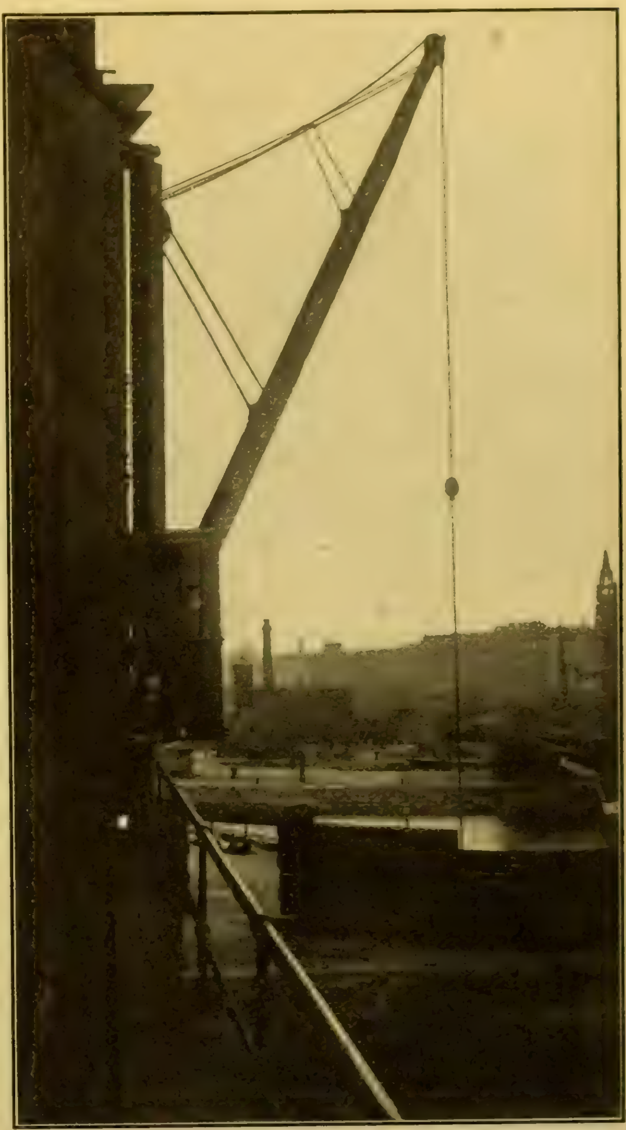
All cranes of the designs referred to above have the hoisting and turning cylinders and most of the piping housed inside the pedestals, which in winter are heated by gas, when required to prevent damage by frost. Each has a fixed cabin on each side of the pedestal, with a set of handles for working the pressure and return valves of the hoisting and turning rams, the cabin used being the one most convenient for the driver seeing the loads when working the crane. The compound 5 and 2-ton and 5 and 3-ton cranes are each provided with a hydraulic motor and gearing for travelling them along the quays. Pressure water is led to the cranes by walking pipes, or by hydraulic hose piping with special couplings, and the return water is conducted from the cranes by armoured rubber and canvas hose with couplings connected to the most convenient hydrant box. All the cranes are rapid in their movements and can lift ore or general cargo as fast as it can be brought within the range of the hook.

Where sheds or warehouses are within a few feet of the quay edge,



TRIPLE-POWER MOVABLE CRANE. ONE FOOT ON THE QUAY AND ONE ON WAREHOUSE BALCONY.

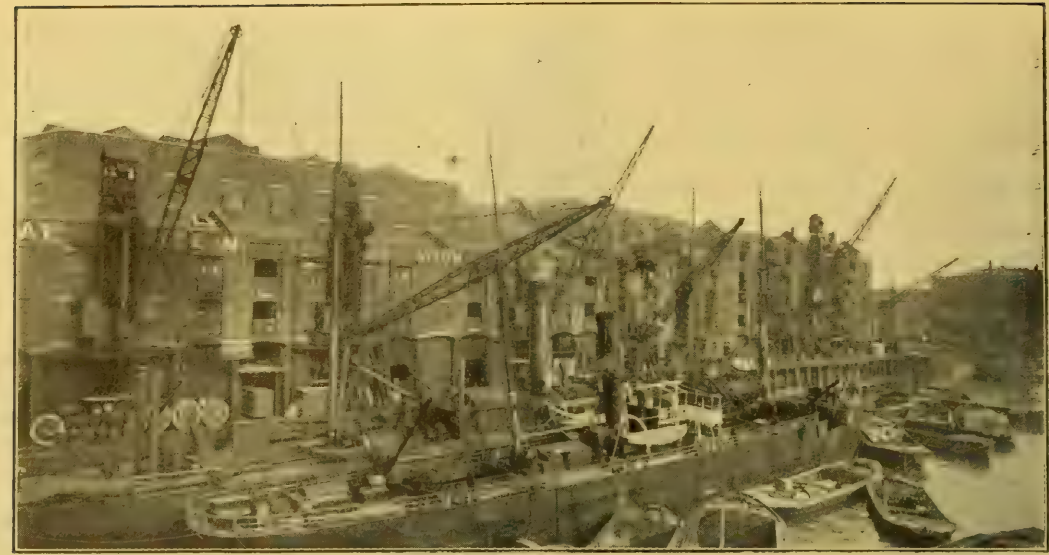
Fullarton, Hodgart & Barclay, Ltd., Paisley.



HYDRAULIC BALCONY CRANE.

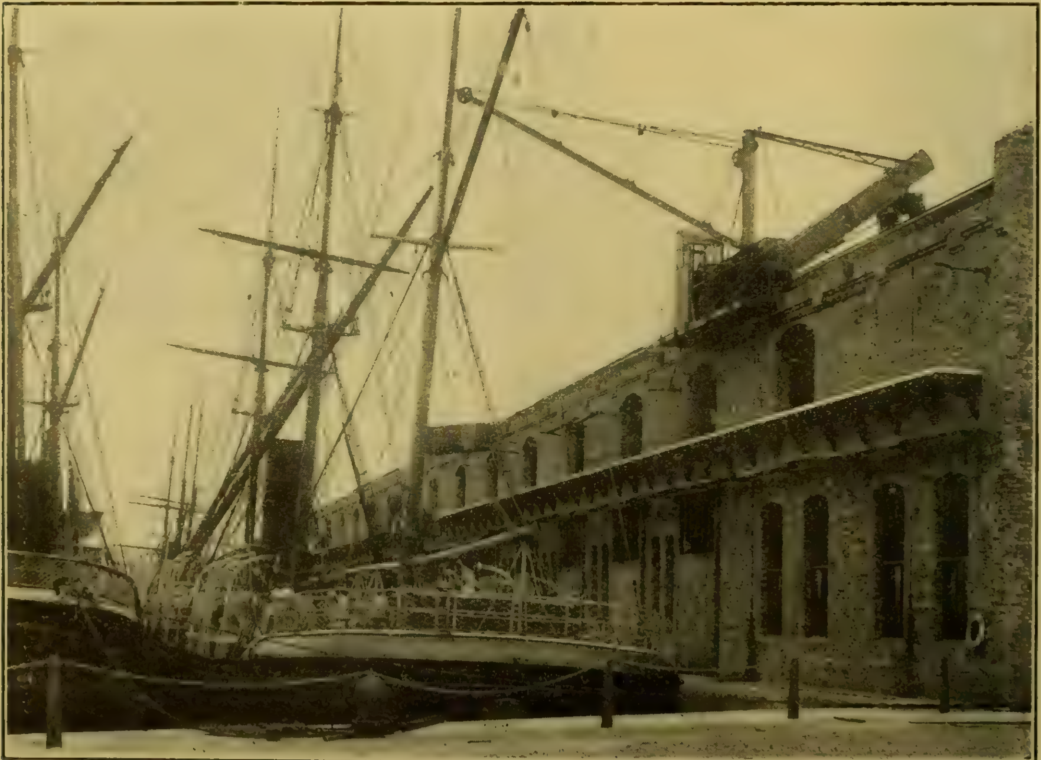
the cranes are frequently designed to travel along the roof, as shown in the photograph on page 192, a system largely adopted at the Liverpool docks. In such cranes the hoisting rams and pulleys are usually arranged in the plate-iron box lying on the slope of the roof, and the turning rams in the longitudinal box. It need scarcely be said that the walls and roof of such buildings require to be specially constructed to sustain the weight of a number of such cranes with their loads and counterbalance weights. The Liverpool cranes shown are constructed to lift loads of 30 hundredweight to a height of 76 feet and are travelled along the roof to any position by hand gearing. Another type known as the "balcony" crane is shown on this page. Such cranes are carried on rails fixed to the walls of the warehouse high enough up to clear all shipping.

At Irongate and St. Katharine's wharves of the General Steam Navigation Company at Deptford there are a set of seven balcony cranes made by Messrs. Fielding & Platt, Ltd., Gloucester, and shown on page 192. Six of these are 30-hundredweight cranes having a maximum radius of 65 feet, a minimum radius of 20 feet, and 75 feet range of lift. Each is fitted with hydraulic lifting, slewing, and luffing motions, and Fielding's patent compensating balance gear giving economy of power and smoothness of working, and another patent arrangement whereby the load is carried at about the same level



BALCONY CRANES, DEPTFORD WHARVES OF THE GENERAL STEAM NAVIGATION CO.
Six 30-cwt. and one 60-cwt. Fielding & Platt, Ltd., Gloucester.

throughout the entire range of the luffing movement. The remaining crane is similar to the others but capable of lifting 3 tons or 30 hundredweight as desired. The illustrations show one of the cranes luffed out to its utmost extent, clearing one vessel and taking goods from the



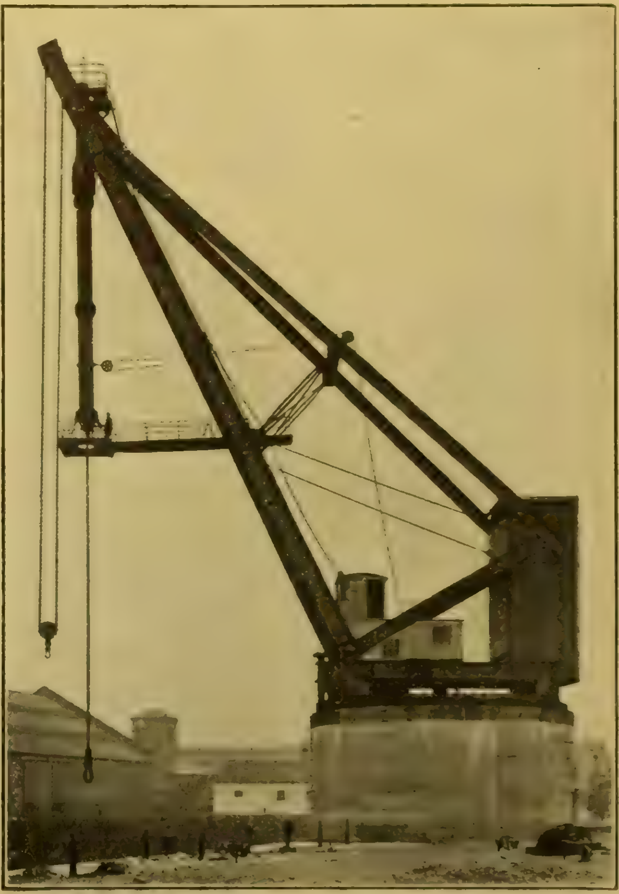
HYDRAULIC CRANE TRAVELLING ON WAREHOUSE ROOF ("SPARROW CRANE"), LIVERPOOL DOCKS.
Sir W. G. Armstrong, Whitworth & Co.

hold of another lying alongside, which will give some idea of the range and capacity of this installation.

An important feature of these balcony cranes is that the whole of the working gear is supported and contained by a steel framework outside the warehouse wall, thus avoiding the waste of storage space inside and the risk of damage to goods by water.

The illustration at the head of this article shows a rather uncommon type of movable hydraulic crane chiefly used for discharging coal, ore, etc., from ships and delivering it overside or into trucks on the quay, the loads being in either case weighted by steelyard on the jib. For delivering overside, a hinged extension jib is used which is turned up out of the way when delivering on the quay, for which purpose the cranes have a turning movement.

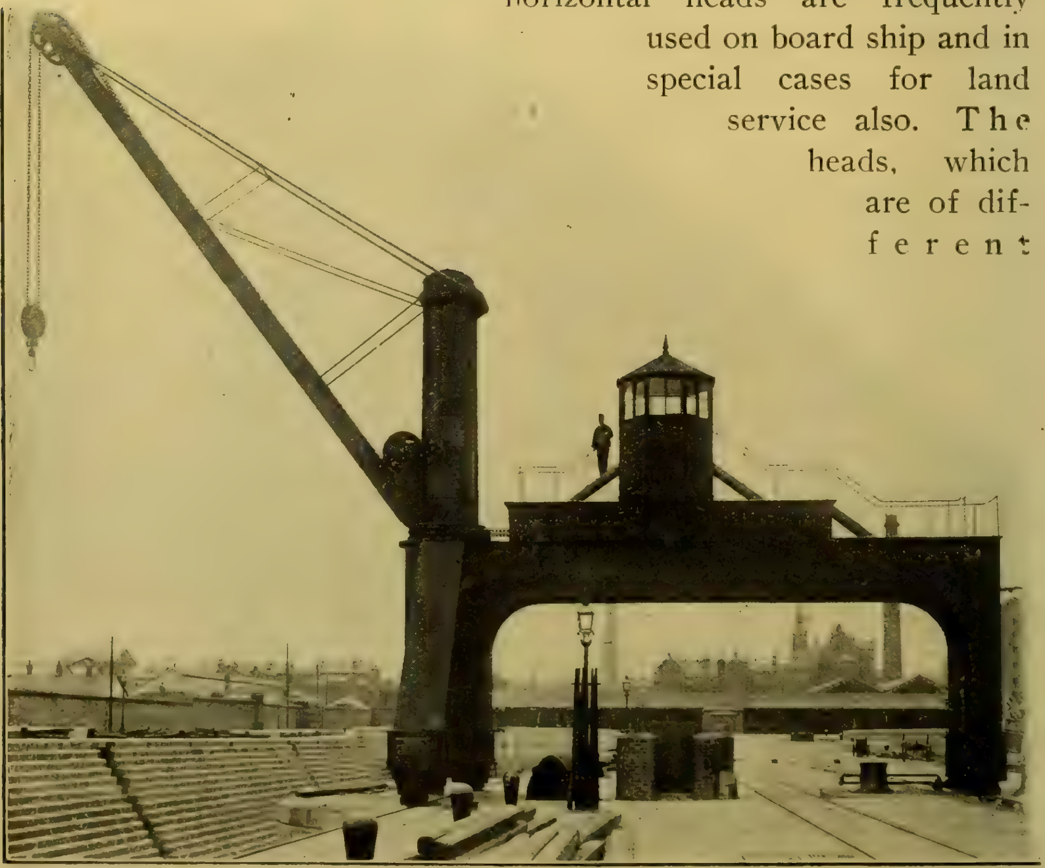
The photograph on this page shows a large hydraulic crane erected at Liverpool by Sir W. G. Armstrong, Whitworth & Co., Ltd. It is capable of lifting 100 tons by means of a direct-acting cylinder suspended from the end of the jib, the range of lift being 50 feet. When more height or length of lift is required for masting ships, the chain purchase beyond the cylinder is used. The lifting power of this purchase is usually 30 tons and the range of lift 80 feet. The crane is mounted on live rollers and is turned by a hydraulic engine. Similar cranes are being erected at Spezia, Malta, Bombay, Venice, and at one of the Government dockyards in Japan.


100-TON HYDRAULIC CRANE, LIVERPOOL.

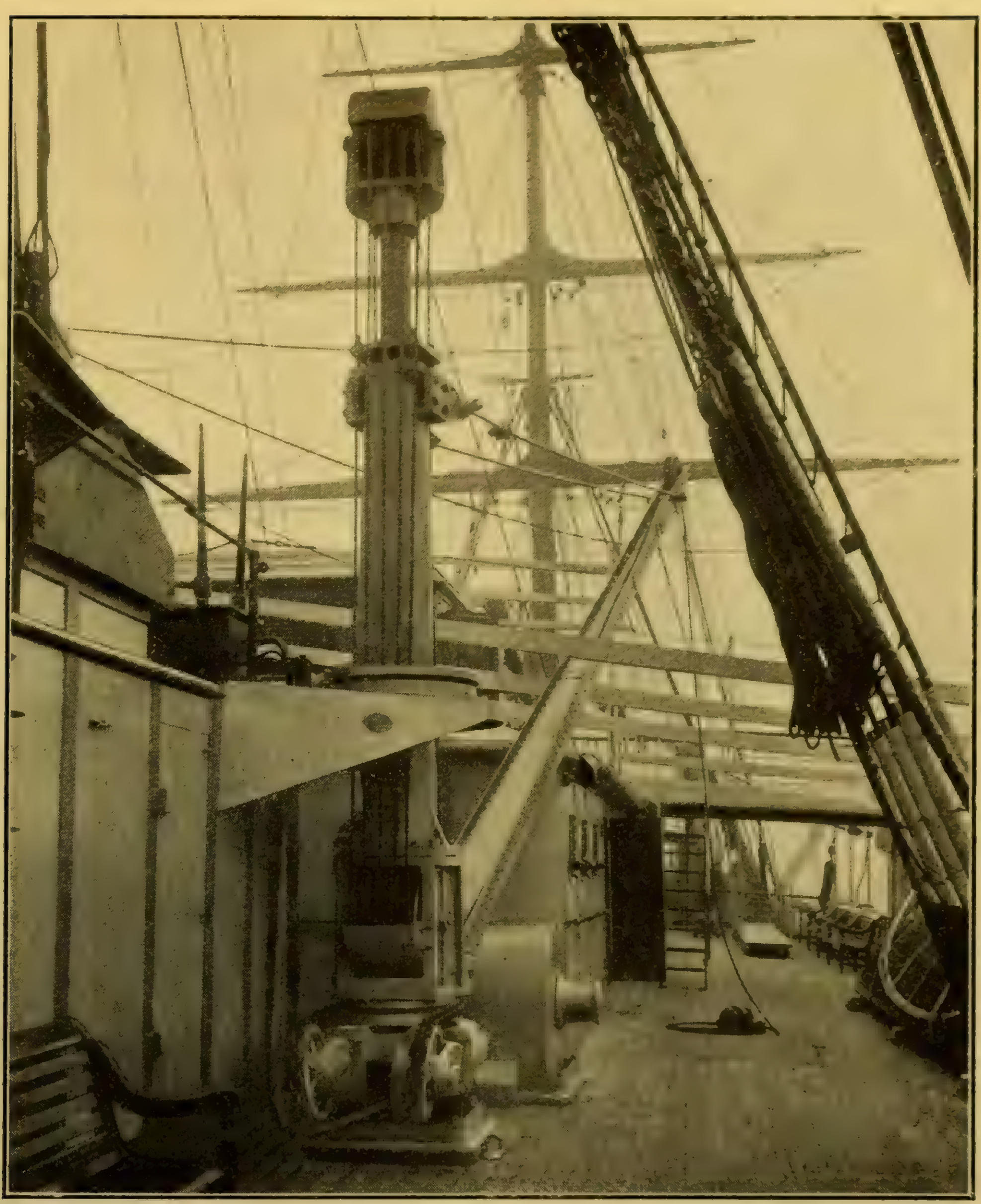
A 30-ton movable hydraulic crane specially designed for graving dock use is shown in the photograph on the page following. It is so constructed that it serves two docks lying alongside one another. At the end of its path is a semi-circular track round which it is moved when required for use at the adjacent dock.

Hydraulic cranes are frequently provided on passenger ships in place of steam cranes, being so much cleaner and perfectly noiseless. All the larger Peninsular and Oriental steamers and similar vessels are equipped with such cranes, of which illustrations are given showing how they are arranged on shipboard. In this design the hoisting cylinder is utilised to form the mast of the crane, the middle bearing being arranged in a cast-iron sole fixed to the upper deck. The jib stays are secured to pins at the top of the cylinder and can be unshipped so as to admit of the jib being lowered down on the deck if required. The turning cylinders are arranged close down to the deck and the whole design is very compact and simple. By the multiple pulleys the hook is raised 10 feet for every foot stroke of the ram, thus admitting of a large range of lift. The handles for working the valves are most conveniently arranged on the upper deck, from whence the driver can see the load as it comes up the hatch.

Where such power is available hydraulic bollards or capstans with horizontal heads are frequently used on board ship and in special cases for land service also. The heads, which are of different



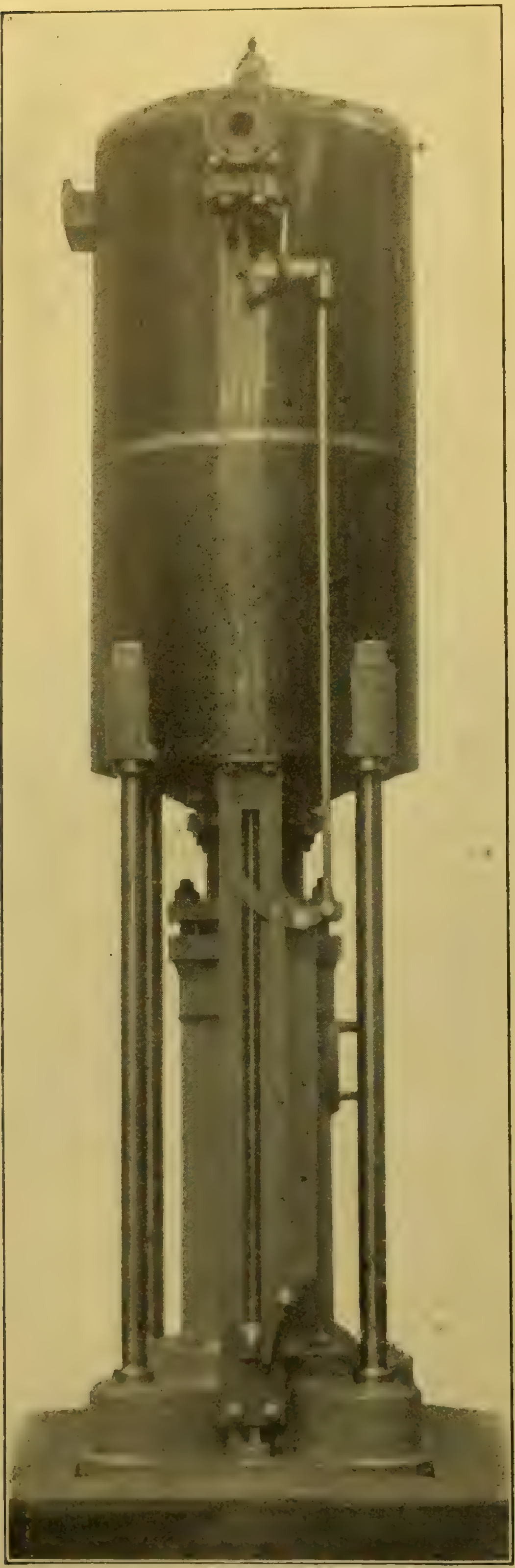
30-TON MOVABLE HYDRAULIC CRANE, FOR SERVING TWO GRAVING DOCKS.



HYDRAULIC CRANE INSTALLED ON SHIPBOARD, P. & O. STEAMER.

diameters to give two speeds, are mounted on the ends of a crank shaft driven by a three-cylinder hydraulic engine, the rams of which work on a common crank pin. The greater portion of one side of the engine casing is made removable to give access for examination and repair. This is a most useful appliance, very suitable for the many kinds of haulage work required on board a large steamer.

The ordinary loaded accumulator as used on land is unsuitable for steamships; such a weight sliding up and down in a vessel rolling about in a sea way would be quite impracticable. The hydraulic accumulator used at sea is loaded by steam to any required pressure. One of

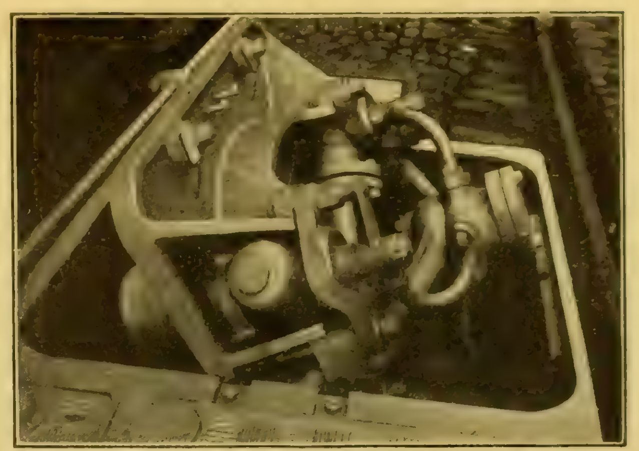


STEAM-LOADED HYDRAULIC ACCUMULATOR FOR MARINE USE.
Fullarton, Hodgart & Barclay, Ltd.

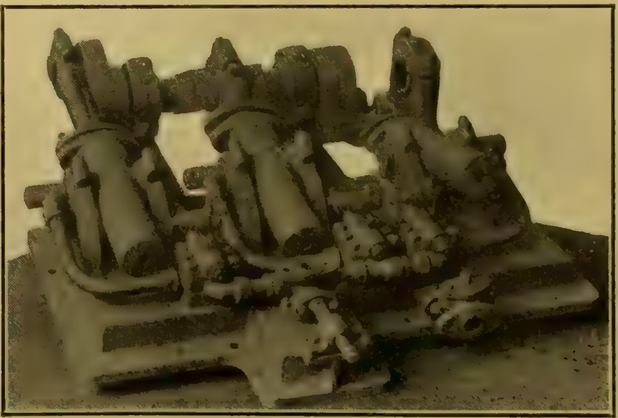
these is illustrated on this page. It will be seen that the steam cylinder is mounted on four columns secured to the sole plate. It has a spring-packed piston, top and bottom buffer springs, safety valve, etc. The piston rod, usually of cast iron, is prolonged through the stuffing box and serves as a ram for the hydraulic cylinder which is bolted to the sole plate directly underneath the steam cylinder.

Another application of hydraulic power on board ship is illustrated in the engraving on page 200, where a hopper barge is shown fitted with hydraulic cranes working grabs for dredging. This description of dredger is very useful for working in confined spaces in docks and basins where a dredger of the bucket or suction type could not be worked. The hopper is filled with spoil brought up by the grabs, and the barge is then taken to sea, where the material is deposited.

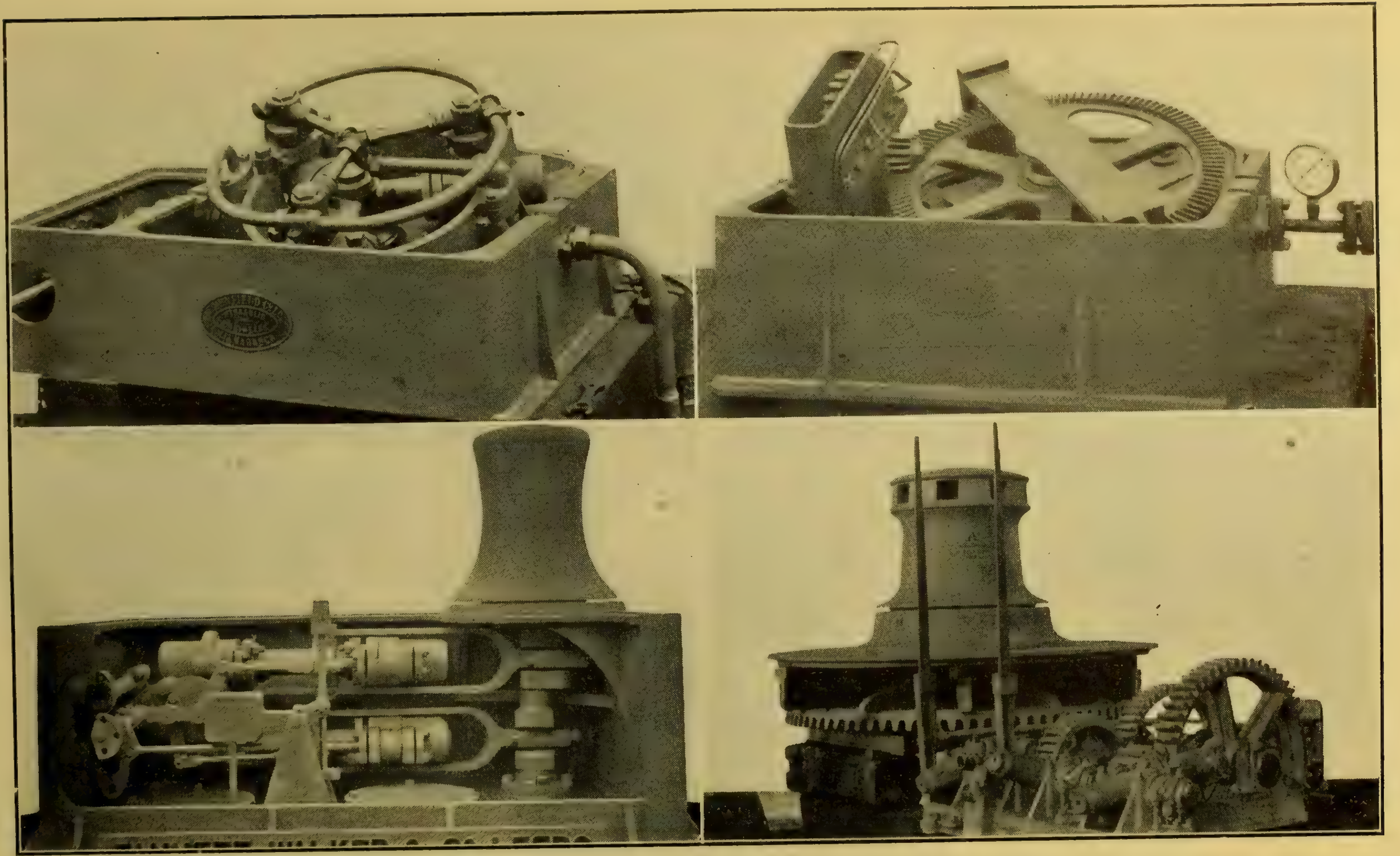
The picture on page 199 shows a movable hydraulic jigger hoist for discharging light cargo from ships and making up lifts ready for cranes. It is a simple appliance, consisting of a cylinder and ram with multiple pulleys working a chain, one end of which is fixed and the other wound round a barrel connected with a rather large narrow drum on which a wire rope is wound and led over a pulley to the hold of the vessel. The whole is mounted on a carriage with wheels, so that it is easily transported wherever required. The wire rope moves about 16 feet for each foot of the ram.


HYDRAULIC TURN-OVER CAPSTAN, CENTRAL-VALVE TYPE.

Capstans. — Many capstans are used for hauling wagons, etc., on dock mineral quays, at coaling berths, and on lines of railway leading thereto, and also at many railway goods yards. The photograph here shows a capstan very commonly used for these purposes; it is of the turn-over type, made by the Elswick firm, and is most convenient for access for overhauling. In this design there are three cylinders oscillating in trunnion bearings in the base plate, the there rams of which act on the crank pin, driving the capstan head which is securely fastened to the crank shaft by a strong key and a left handed screw nut. A flat circular valve, central with the crank shaft, is worked by it, admitting pressure and releasing exhaust water to and from each separate cylinder. The base plate is supported on two trunnions working in bearings in the framing. Stuffing boxes are fitted to the outside ends of the trunnions, the water entering through one end, passing through the cylinders, and exhausting at the other end. The base plate can turn a complete revolution, thus exposing all the working parts. In some cases (and it is a very desirable adjunct for turning the base-plate) a worm and quadrant are fitted, which also serve the purpose of locking the base-plate in any position. When working, the latter is securely locked to the


THREE-CYLINDER ROTARY HYDRAULIC ENGINE.

The cylinders oscillate in trunnion bearings, the valves being worked by cranks cast on the trunnions.
Sir W. G. Armstrong, Whitworth & Co.

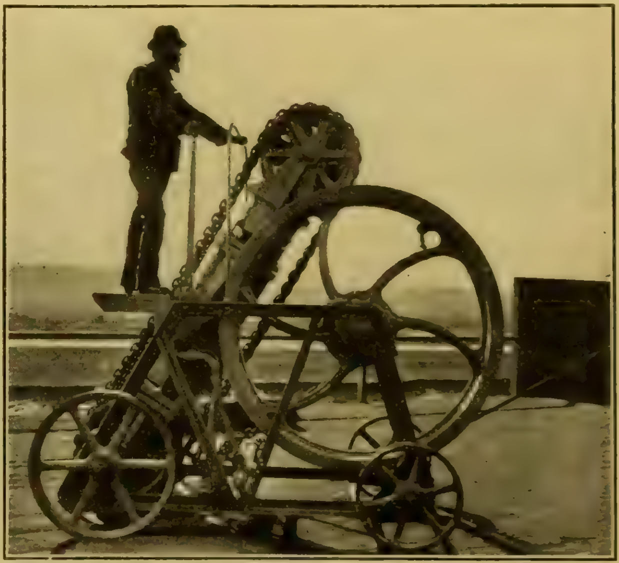


TYPES OF HYDRAULIC CAPSTANS, OF FIXED AND TURN-OVER DESIGNS.

The upper left figure shows a capstan by the Glenfield Co., with admission and release of water through a valve chest bolted to the end of one trunnion. The other turn-over capstan, to the right, is by the same makers. This is driven by a Pelton wheel, as described on page 199. Below to the left is the Tannett, Walker & Co. four-cylinder capstan described on page 199, and to the right of that the 11-ton Elswick geared capstan for hauling vessels in and out of docks.

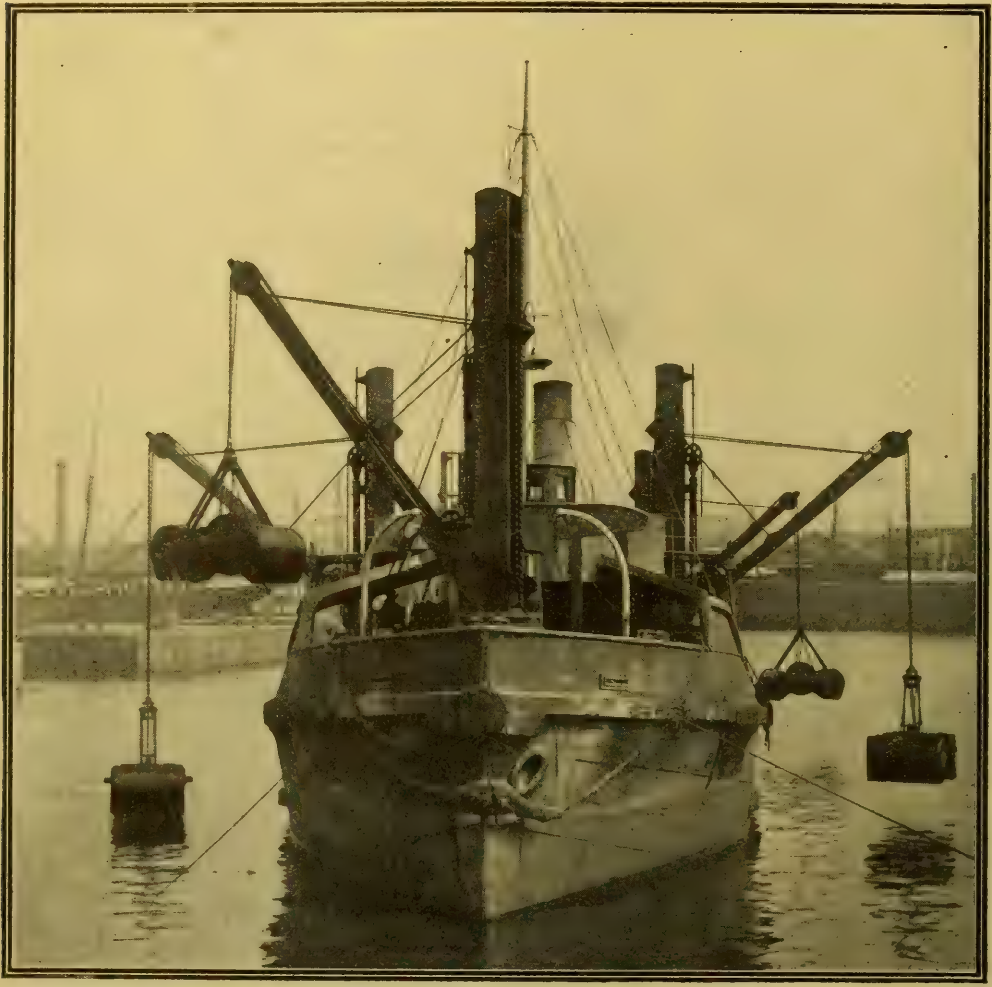
frame with iron catches. In another design of turn-over capstan, it will be seen from the photograph that the admission and release of water to each cylinder is regulated by a gun-metal valve working in a valve chest bolted to the end of one of its trunnions. The consumption of water by these capstans is 1.087 gallons per revolution.

Another design of turn-over capstan is the one shown by the photograph on page 198, worked by a Pelton wheel and gearing. The supply of pressure water is regulated by two nozzles, either or both of which may be used according to the pull required on the capstan. The consumption of pressure water at full power is much the same as the capstans previously described but, for obvious reasons, in place of the water being returned to the pumping station after being used by the wheel it is run into the dock. One disadvantage of these capstans, for rapid working, is the slight delay caused by the acceleration required by the Pelton wheel at starting. One considerable advantage, however, is that the upkeep is somewhat less; the water used at half power is also much less, and again, in isolated positions where a capstan may be only occasionally required, it is always ready for use, but when the three-cylinder type have to stand idle for any length of time the cup leathers are apt to get dry and leak when the capstan is most wanted. The Pelton wheel is 18 inches diameter and the speed 2,000 revolutions per minute, the speed of the capstan head is 80 revolutions per minute, the two jets are 3-16-inch diameter, and the pressure normally is about 700 pounds per square inch. Another well-known type of capstan, much adopted throughout the docks and railway yards of Great Britain, is the four-ram hydraulic railway capstan of which a large number have been made by Tannett, Walker & Co., Ltd., of Leeds. In this design there are, as shown by the photograph, two pairs of single-acting rams, each pair acting on one crank pin at right angles with the other. The upper pair of rams actuate the valve gear for regulating the admission and release of



MOVABLE HYDRAULIC JIGGER HOIST FOR LIGHT CARGO.

water to the lower, which, in turn, work the valve gear of the upper pair of rams. The arrangement is very simple and compact and the light chequered wrought-iron plates on top are made removable to give access to the working parts for overhauling. The pulling power is one ton and the consumption of water at 750 pounds pressure, like the others, is 78 gallons per revolution.



HOPPER BARGE, WITH HYDRAULIC GRABS FOR DREDGING.
Built at the Elswick Works.

An illustration is given also on page 198 of a hydraulic capstan of 11-tons hauling power for dock use; the hydraulic engine and gear are arranged in a chamber below quay level. Vessels are now so large and heavy that powerful capstans such as these are required to work them in and out of dock.

In conclusion I have to acknowledge indebtedness to those firms who have so kindly supplied me with photographs and descriptions of their apparatus, and also to the authorities quoted in connection with the historical portions of this article.

COST KEEPING AND SHOP STATISTICS FOR A REPAIR SHOP.

By Albert W. Thompson.

The shop described by Mr. Thompson represents a very large class—that having no fixed line of manufacture or output—and one to which it seems especially hard to adapt an exact cost-keeping system. His article is thus invested with an unusual interest, which is well maintained in the manner of treatment.—THE EDITORS.

IN view of the extent to which cost keeping is practised in up-to-date shops at the present day, one might expect to find much similarity in the methods employed; but an examination of the systems used in many of the leading shops, descriptions of which have from time to time appeared in THE ENGINEERING MAGAZINE, will cause the reader to note that contrasts rather than similarities seem to be the rule. These differences in method, however, do not indicate differences in merit, for they arise from differences in the requirements imposed by circumstance; and the best system which can be devised for any particular shop is that which is best adapted to its individual requirements.

It is quite evident, then, that standard methods of cost keeping cannot readily be developed, even for manufacturing shops whose product has a certain amount of homogeneity; and it follows from this that in repair shops, which in one sense of the word have no product, we must resort to methods having little in common with those employed in manufacturing shops.

In devising such a system our real object is to reduce cost. We must take care, then, not to overburden ourselves with red tape and clerical expense, thereby defeating our own object, and we must distinguish carefully between the necessary and the superfluous. I believe that in a repair shop certain principles may be applied with good results, which might however be very poor policy in a manufacturing shop. For example, in fixing rates, approximation should be practised, instead of absolute accuracy. That is, we should pay special attention to means and averages, rather than to a mass of detail which confuses the mind and affords no real basis for comparison of results.

If our departments are relatively small we may safely depend on foremen for some clerical work. By using judgment we may thus decrease our clerical expense, at the same time keeping before the eyes of the foremen certain facts and figures which tend to enable them to see the results of their work from a new and beneficial view-point. We must, however, not go beyond the point where the foreman's time is occupied to an extent detrimental to the efficiency of his departmental supervision.

Our foremen must not only supervise but improvise; that is, they must not only carry on their work, but to a large extent must plan the details. To illustrate: A routing and estimating department, invaluable in large shops, would hardly be applicable in a repair shop, where we should still have to have our foremen as supervisors, on account of the variable nature of the work. We could possibly do the work with cheaper foremen, but when good men can be found, perfectly capable both of planning the details of the work and of supervising it, it is, in my opinion, an efficient and inexpensive policy to use them in both capacities; and having such men, we may readily make use of a premium or bonus system of payments without the aid of a routing and estimating department.

We must not try to apply, in all departments, any particular rule or system. For instance, if we try to apply the premium system of payments in all departments, because we meet with good results in several, we shall in all probability cause much dissension and endless bother in many cases. It is perfectly practicable to use the day rate, straight piece work, and the premium plan, not only in the same shop but in the same department, and the use of all three systems may lead to much more efficient organization than if one of the three were strictly adhered to.

The machine shop of the Amoskeag Manufacturing Company, in Manchester, N. H., will serve as an example of a shop in which the principal business is repairs, in which the work presents a great variety of detail, and in which the above principles have been applied. I propose, after describing the shop and its requirements, to describe the methods of keeping costs and obtaining statistics which are here used, as well as a method of using the premium system of rewarding labor in conjunction with the ordinary day-rate system.

This shop makes practically all repairs for the Amoskeag Manufacturing Company, a large corporation manufacturing fancy cotton cloths; the Manchester Mills, a neighboring corporation manufacturing both cotton and woolen goods; and the Manchester Print Works, producing printed cotton cloths. Most of the other mills and small industries in Manchester maintain repair shops, but much of their heavy repairs on engines, water wheels, etc., is done in the Amoskeag shop. In order to present to the reader a more definite idea of the amount of machinery kept in repair by this shop the adjoining table is appended, showing the spindles and looms represented, which, of course, represent a correspondingly large number of fly-frames, cards, pickers, dyeing and finishing machinery, etc., as well as shafting, pulleys and belting, engines, and water wheels. See Table I.

TABLE I. POWER AND MACHINERY IN THE AMOSKEAG SHOP.

	Amoskeag Mfg. Co.	Manchester Mills.	Manchester Print Works.
Annual production, finished cloth......	138,000,000 yds.	10,000,000 yds.	54,000,000 yds.
Number of employees............	7,800 hands	2,500 hands	700 hands
Productive machinery	12,000 looms 320,000 spindles	3,500 looms 76,000 spindles	17 printing machines
Horse power utilized continuously......	14,000 horse power	3,400 horse power	1,000 horse power
" " available, steam	14,000 " "	1,500 " "	800 " "
" " " water	12,000 " "	2,200 " "	600 " "
Derived from outside sources, electric..		600 " "	300 " "

The principal function of this shop is to keep in repair the machinery and power plants of the mills above described, but "repairs" as used in this case is an elastic word and covers a large class of work better defined as alterations, the necessity for which arises from changes and improvements constantly being made in textile machinery, either in response to a demand for some new class of goods, or to facilitate the adoption and introduction of some improved mechanical device. In the following pages, then, repairs refer to work necessitated by wear and breakage. The volume of repair work is practically constant, but the demand for alterations is extremely variable, and when it does exist is urgent. To meet the ever-expected demand for alterations a considerable force is kept employed in the construction of new machinery, which, as the shop is well equipped, can be made at moderate cost. This work can be dropped to meet a sudden demand for alterations and taken up when opportunity offers, and thus a body of trained men is always in reserve, available for any sudden requirements.

A demand also constantly exists for certain small parts of machines which are subjected to more wear and breakage than others, but which are so simple as to be readily replaced by the "section hands" in the mills.

TABLE II. DEPARTMENTS AND ORGANIZATION OF THE SHOP.

	Hands.		*Equipment.*	*Work.*
Machine Shop Proper.	A	30	Bolt and screw machinery, automatic screw machines, milling machines, small lathes, drill presses, grinding and polishing machinery.	Bolts, screws, nuts, studs, pins, springs, hooks and lightest class of machinery parts made and repaired. Grinding and polishing.
	B	60	Light machine tools, chucking machines and automatic gear-cutters, special machinery for making fluted steel rolls.	Manufacturing and repairing looms, spinning frames, roving frames, and other textile machinery of the lighter classes.
	C	30	Medium sized machine tools for general work.	Building and repairing drying, dyeing, and finishing machinery and other textile machinery of the heavier classes. Repairing valves, etc.
	D	25	Planers and heavy machine tools.	Machining and fitting up shafting, hangers, couplings, pulleys, gears, etc. Engine and water-wheel repairs, etc. Heavy machine-tool work.
	E	20	Hand forges, steam and power hammers, special drop forging machinery for bolt work.	Forging of all kinds.
	F	30	Wood-working machinery.	Pattern work. Wood work of all kinds.
	G	12	Sheet-metal-working machinery.	Sheet-metal work and plumbing.
Small Departments in or near Main Shop.	H	10	Belt-making and leather-working machinery.	Belting and strapping made and repaired.
	I	16	Top-roll-covering machinery.	Top rolls re-covered for spinning and carding machinery.
	J	16	Pipe-threading and cutting machines.	Pipe fitting of all kinds.
Gangs having headquarters in and near Shop.	K	25	Painters' apparatus.	Machinery and mill painting.
	L	35	Millwrights' apparatus.	Heavy mill carpentry, hanging shafting, repairing floors, erecting and moving machinery, elevator repairs, etc.
	M	10	Masons' apparatus.	Light masonry, incidental to mill work, machinery foundations, whitewashing, etc.
Boiler Shop.	N	40	Power-shears and punches, plate planer, pneumatic riveting, chipping and drilling tools.	Boilers, steam pipes, tanks, etc., built and repaired. Heavy sheet metal work of all kinds.
Foundry.	O	60	Moulding machines, power cranes and hoists, pneumatic riddlers, chipping hammers, etc.	Iron and brass castings.

Such parts are kept on hand in the company's store house, and are ordered of the machine shop in quantity. This class of work is known in the shop and described hereinafter as "store-house work." The distribution of the labor required for these and other classes of work done for the mills will be shown later.

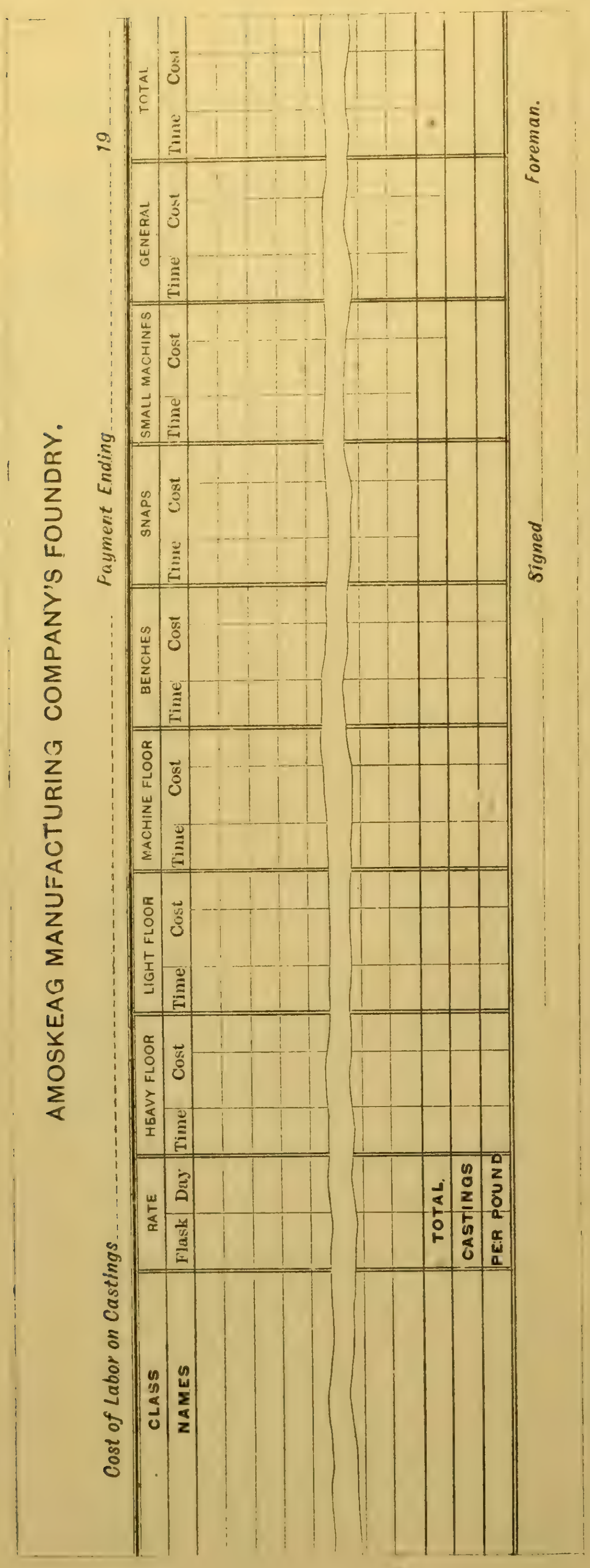
The organization of the machine shop as subdivided into departments will be best understood by referring to Table II., which also indicates the number and size of other departments comprehended in the same management. These departments are all operated by and for the Amoskeag Manufacturing Company. The foundry has its separate account on the company's books, being credited with the value of its output and charged with its expenses, and can show a definite profit or loss at the end of the year. The machine shop, however, cannot be thus treated, since to its principal output—repairs—no definite value can be assigned. All shop expenses, therefore, are charged to the repair account, which is credited with all amounts received in payment for shop work from the Manchester Mills and others, the balance at the end of the year representing the cost of repairs.

The functions of our system are these:—

1.—To determine with reasonable accuracy the cost of all materials and labor expended in work for outside parties, in order that prices may be fixed which will insure a reasonable profit on all such work.

2.—To determine the distribution of and account for the repair expense of the different departments of the mills of the Amoskeag Manufacturing Company and the Manchester Mills.

In the foundry a great variety of castings is produced, ranging from heavy gear and pulley castings weighing several tons down through all intermediate grades to the lightest possible class of machinery castings made in "strings" on the benches. Hand work prevails, though moulding machines are used wherever the number of pieces required warrants the initial expense of fitting up the patterns. Under these conditions the mean cost of labor per pound is far from being a good index of efficiency or basis for prices, for a change in the average weight causes a change in the mean cost per pound, and both vary considerably from month to month. The work is therefore divided into several classes, whose names (which are self-explanatory) appear in the column headings of the form shown in Figure 1. Payments are made every two weeks, and at the end of each payment each workman's labor and its cost is entered in the column or columns corresponding to the work on which he was engaged. This division of



AMOSKEAG MANUFACTURING COMPANY'S FOUNDRY.

Cost of Labor on Castings .... *Payment Ending* .... 19 ....

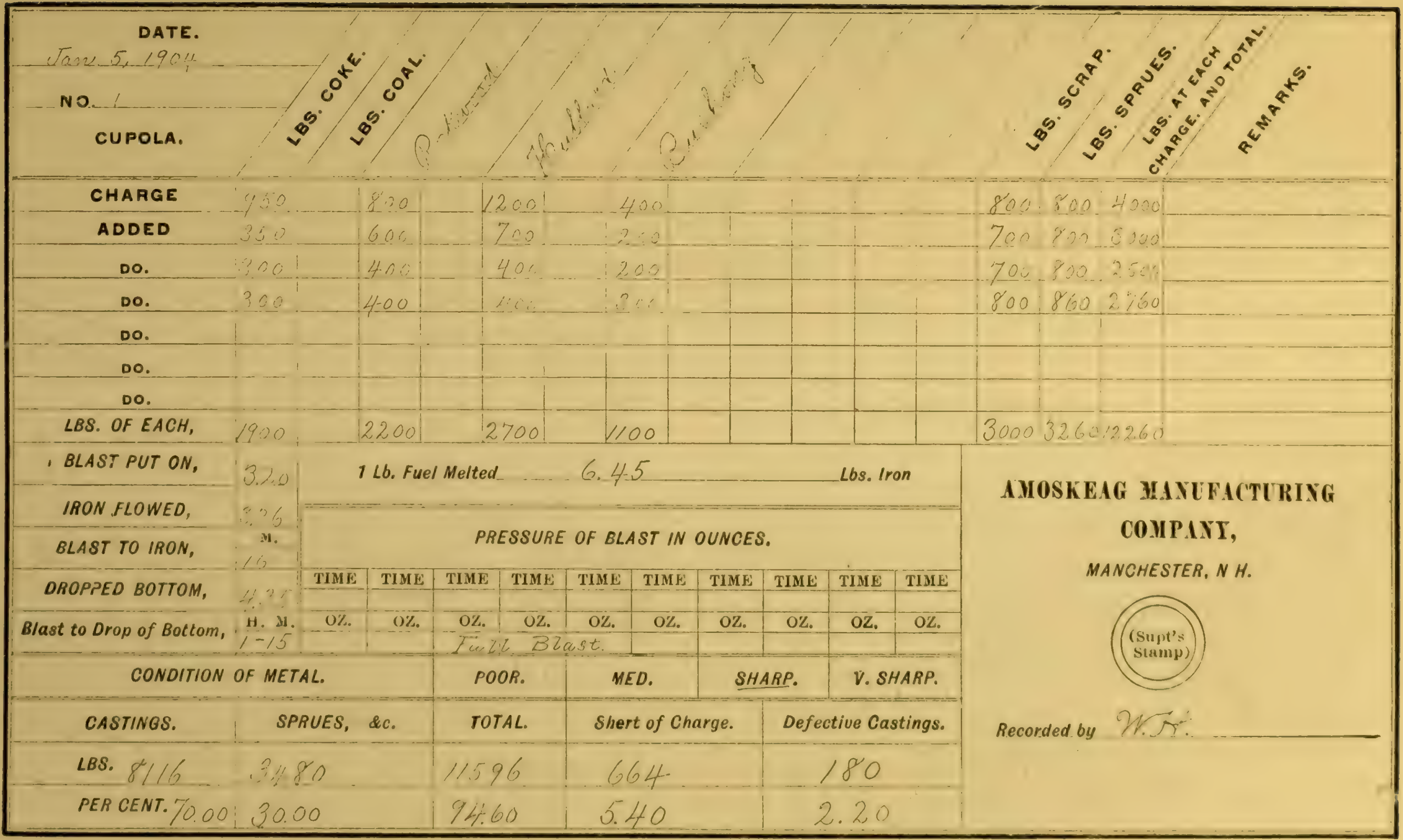
CLASS	RATE		HEAVY FLOOR		LIGHT FLOOR		MACHINE FLOOR		BENCHES		SNAPS		SMALL MACHINES		GENERAL		TOTAL	
NAMES	Flask	Day	Time	Cost	Time	Cost	Time	Cost	Time	Cost	Time	Cost	Time	Cost	Time	Cost	Time	Cost
	TOTAL.																	
	CASTINGS																	
	PER POUND																	

Signed .... *Foreman.*

FIG. 1. FORM FOR CLASSIFICATION AND RECORD OF FOUNDRY WORK.
The original is 13¾ inches wide and 14 inches high, ruled in red and blue.

cost is not difficult, since the men are not often changed from one class of work to another. Knowing the weight of castings produced of each class, we can determine separately for each the cost of labor per pound. The cause of any marked variation in the cost of any one class is usually easily detected, and, conversely, the introduction of new methods or apparatus is usually plainly reflected in the cost figures.

A daily record of the results of each melt is also kept, as shown in Figure 2. This is of great use in determining the effects and proper proportions in which to use new irons, and any sudden falling off in the quality of castings can usually be traced to its cause by an inspection of the files. A record of all supplies and stock used is also kept, and at the end of each month (four weeks) all figures are



DATE. Jan 5, 1904

NO. 1

CUPOLA.

	LBS. COKE.	LBS. COAL.	[illegible]	[illegible]	[illegible]	LBS. SCRAP.	LBS. SPRUES.	LBS. AT EACH CHARGE, AND TOTAL.	REMARKS.
CHARGE	950	800	1200	400		800	800	4000	
ADDED	350	600	700	200		700	800	3000	
DO.	300	400	400	200		700	800	2500	
DO.	300	400	400	300		800	860	2760	
DO.									
DO.									
DO.									
LBS. OF EACH,	1900	2200	2700	1100		3000	3260	12260	

BLAST PUT ON, 3.20

1 Lb. Fuel Melted 6.45 Lbs. Iron

IRON FLOWED, 3.26

BLAST TO IRON, M. 16

DROPPED BOTTOM, 4.25

PRESSURE OF BLAST IN OUNCES.

	TIME	TIME	TIME	TIME	TIME	TIME	TIME	TIME	TIME	TIME
Blast to Drop of Bottom, H. M. 1-15	OZ.	OZ.	OZ.	OZ.	OZ.	OZ.	OZ.	OZ.	OZ.	OZ.
			Full Blast.							

CONDITION OF METAL.	POOR.	MED.	SHARP.	V. SHARP.

CASTINGS.	SPRUES, &c.	TOTAL.	Short of Charge.	Defective Castings.
LBS. 8116	3480	11596	664	180
PER CENT. 70.00	30.00	94.60	5.40	2.20

AMOSKEAG MANUFACTURING COMPANY,

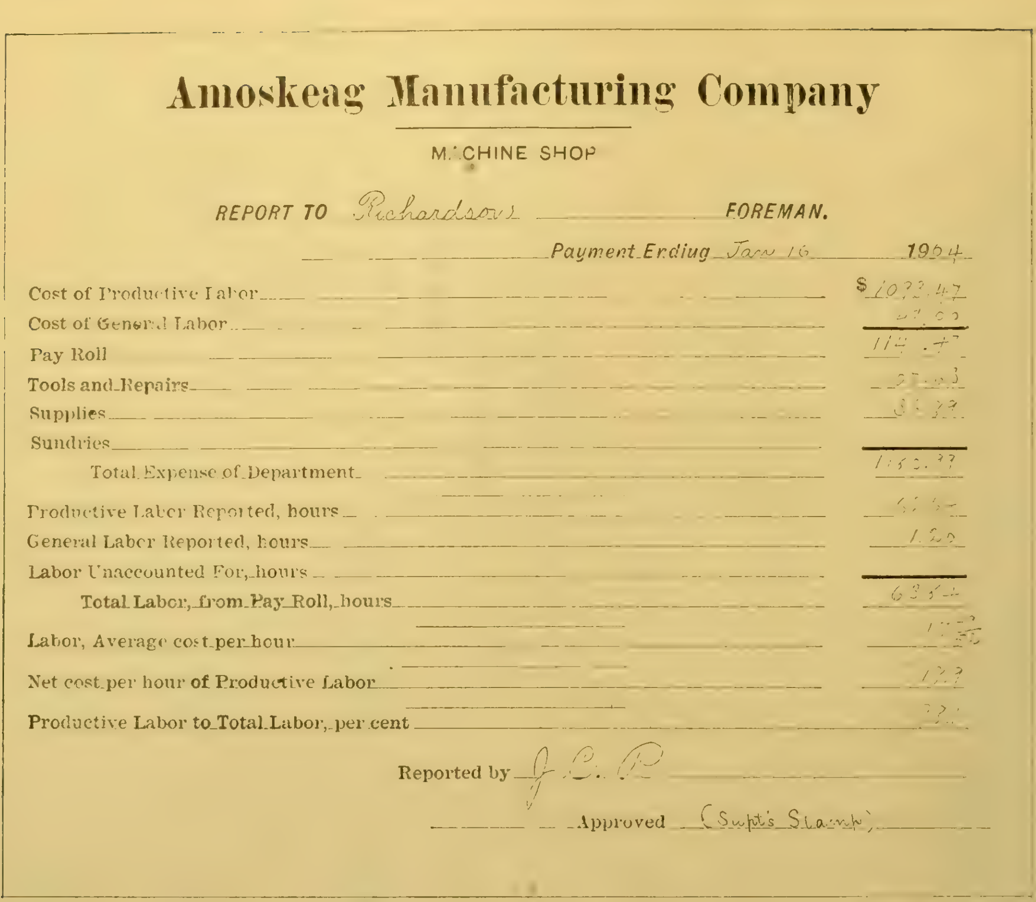
MANCHESTER, N H.

(Supt's Stamp)

Recorded by W. F.

FIG. 2. DAILY RECORD OF RESULTS OF EACH MELT.

The original is 8 inches high and 12 inches wide. This form is adopted, with slight changes, from one used by a well-known New England firm, by whose kind permission it is used here.



Amoskeag Manufacturing Company

MACHINE SHOP

REPORT TO Richardson FOREMAN.

Payment Ending Jan 16 1904

Cost of Productive Labor	$1033.47
Cost of General Labor	81.00
Pay Roll	114.47
Tools and Repairs	[illegible]
Supplies	[illegible]
Sundries	
Total Expense of Department	[illegible]
Productive Labor Reported, hours	[illegible]
General Labor Reported, hours	1.20
Labor Unaccounted For, hours	
Total Labor, from Pay Roll, hours	6354
Labor, Average cost per hour	[illegible]
Net cost per hour of Productive Labor	[illegible]
Productive Labor to Total Labor, per cent	[illegible]

Reported by J. C. P.

Approved (Supt's Stamp)

FIG. 3. FORM FOR ENTRY OF COST OF PRODUCTIVE LABOR.

The original is 8½ inches wide and 7¼ inches high.

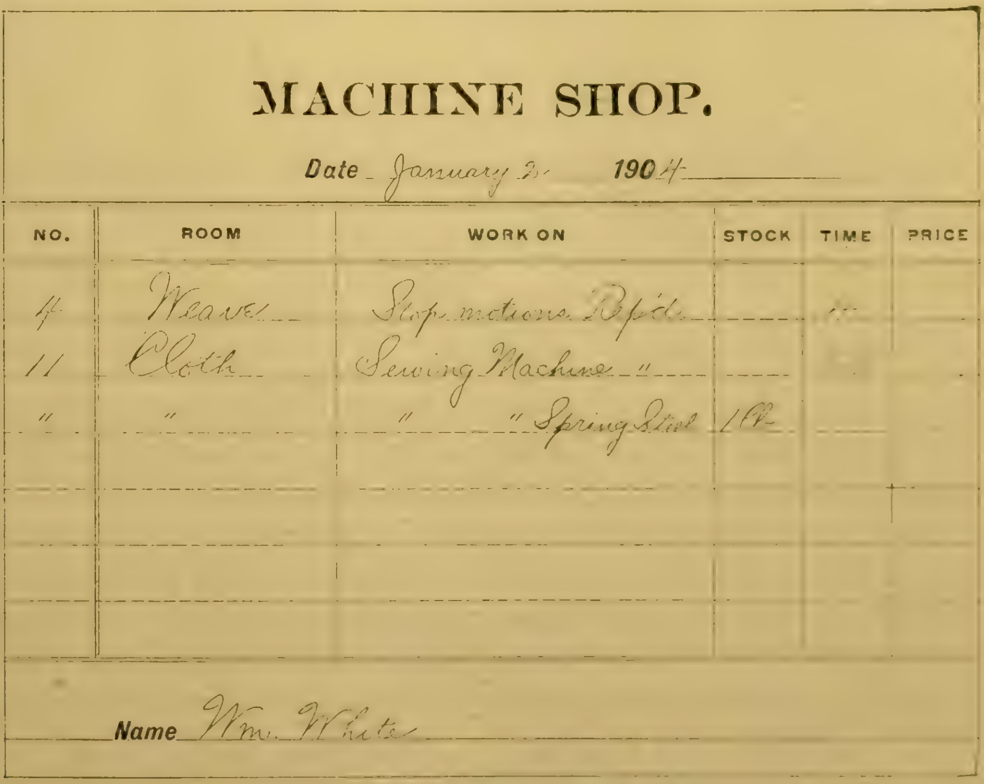
returned to the office of the shop superintendent, where a report to the management is made out showing the results of the month's work, summarized. The last monthly period in each six months contains six weeks instead of four, the object of this arrangement being to make the monthly periods begin and end with the two-week payments used by the company.

The foundry usually employs about 60 hands. One clerk only is employed, who acts as time keeper, weighs off and records all castings, makes out reports, and makes up all accounts for outside work.

In the machine shop, to secure absolutely accurate costs we should have to take into account the individual wage rate of each employee. To escape the immense amount of clerical work which would thus be necessitated it has been found advisable to determine the net cost of an hour's labor in each department by the following method:—

In each department all labor not chargeable to any particular job is classed as general (or non-productive) labor, including usually the foreman's and part of his second hand's time; also all labor employed in cleaning shop, distributing castings, etc. Subtracting the number of hours of general labor from the total number of hours actually shown on the pay roll, we have the number of hours of productive labor for this department. Adding to the total cost of labor shown on the pay roll the cost of all small tools, supplies, minor repairs, etc., chargeable to the department within a given period of time, we have the total expense; this, divided by the number of hours of productive labor, gives the net cost per hour of productive labor. To this figure must be added the general expense for the entire shop and the usual fixed charges, all reduced to expense per hour of productive labor.

The cost of productive labor for each department is determined at the end of every payment, and entered on the forms shown in Figure 3. After being inspected and approved by the superintendent these are distributed to the foremen. Each foreman is thus provided with an index of his success in maintaining a low labor cost by keeping down his general expense, and this practice does much toward the prevention of careless ordering and use of supplies and encourages the maintenance of efficient departmental organization. In support of this method of determining the cost of labor it should be said that experiments, carefully made, show that whether the cost of a given



MACHINE SHOP.

Date January 2 1904

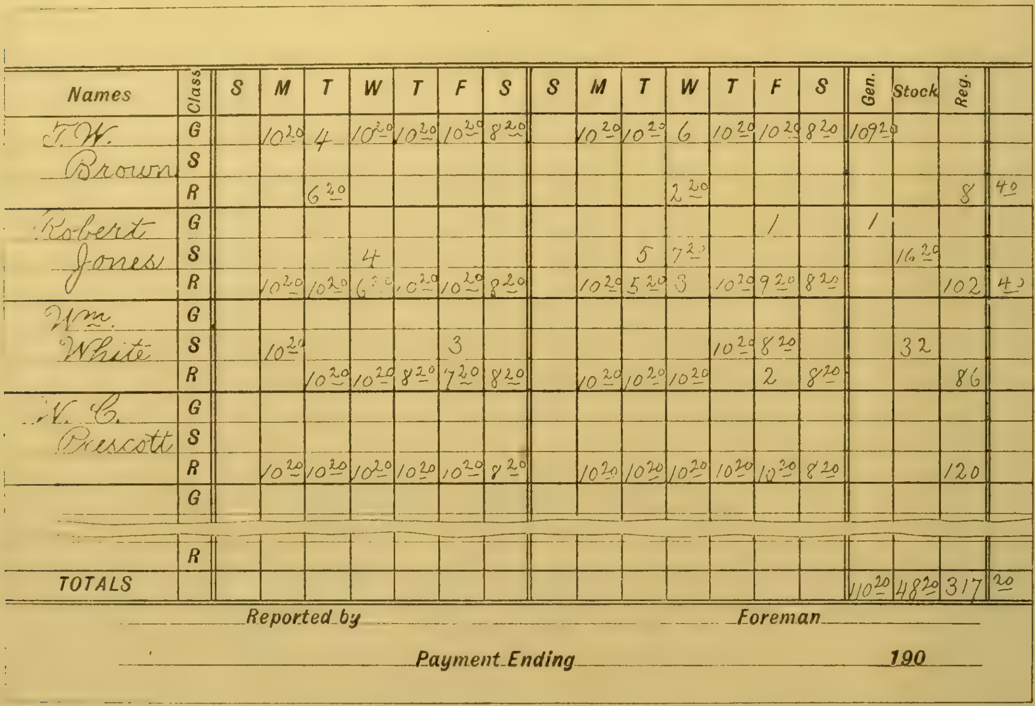
NO.	ROOM	WORK ON	STOCK	TIME	PRICE
4	Weave	Stop motions Rep'd.			
11	Cloth	Sewing Machine "			
"	"	" " Spring Steel	1 lb.		

Name Wm. White

FIG. 4. DEPARTMENTAL TIME CARD.
The original is a card 5½ inches wide and 4½ inches high.

job is figured on the mean basis or on the individual basis the results are so close that the differences are negligible in practice. Moreover the cost per hour of labor in the different departments varies so slightly from the mean for the entire shop that it has been found desirable to adopt one price for all departments.

Excepting in one or two small departments where only one line of work is conducted, time cards (Figure 4) are used. Time cards are kept by individual workmen and checked daily by the foremen, but the clerical work involved is not formidable, since so many hands, in many cases in gangs, are employed for several consecutive days on one job.



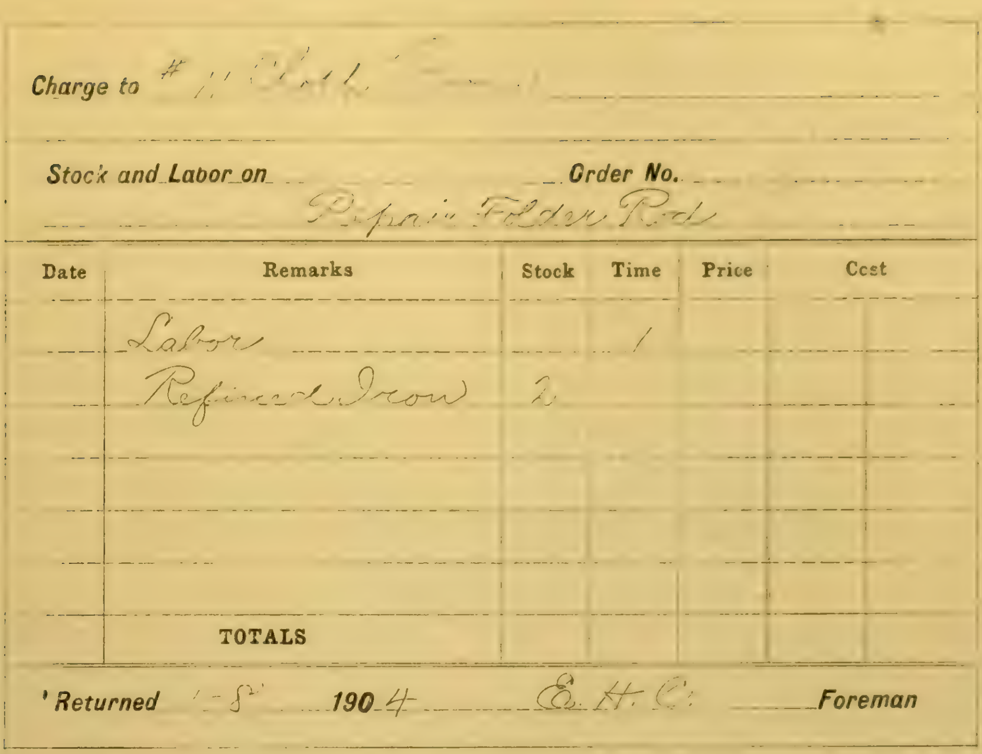
Names	Class	S	M	T	W	T	F	S	S	M	T	W	T	F	S	Gen.	Stock	Reg.	
T. W.	G		10^{20}	4	10^{20}	10^{20}	10^{20}	8^{20}		10^{20}	10^{20}	6	10^{20}	10^{20}	8^{20}	109^{20}			
Brown	S																		
	R			6^{20}								2^{20}						8	40
Robert	G													1		1			
Jones	S				4						5	7^{20}					16^{20}		
	R		10^{20}	10^{20}	6^{20}	10^{20}	10^{20}	8^{20}		10^{20}	5^{20}	3	10^{20}	9^{20}	8^{20}			102	40
Wm.	G																		
White	S		10^{20}				3						10^{20}	8^{20}			32		
	R			10^{20}	10^{20}	8^{20}	7^{20}	8^{20}		10^{20}	10^{20}	10^{20}		2	8^{20}			86	
N. C.	G																		
Prescott	S																		
	R		10^{20}	10^{20}	10^{20}	10^{20}	10^{20}	8^{20}		10^{20}	10^{20}	10^{20}	10^{20}	10^{20}	8^{20}			120	
	G																		
	R																		
TOTALS																110^{20}	48^{20}	317	20

Reported by ____________ Foreman ____________

____________ Payment Ending ____________ 190

FIG. 5. FOR CHECKING TIME CARDS AND SEPARATING GENERAL FROM PRODUCTIVE LABOR. The original is 8½ inches wide and 14 inches high. The reproduction shows only the heading, footing, and plan of ruling.

To check the time shown by the cards and to separate general labor from productive, the form shown in Figure 5 is used. The figures shown in this form are taken from the time cards by a clerk, and failure to check with the time-keeper's records results in investigation. All labor unaccounted for is charged to the general expense of the department, thus showing unfavorably to the foreman, with the natural result that such discrepancies seldom occur. The time cards are sent to the shop office and sorted by the clerks, the entries being transferred to "charge slips" (Figure 6), one charge slip often representing a large number of time cards. Each charge slip indicates the department or account to which the items upon it are chargeable, and is



Charge to # 11 Cloth Room

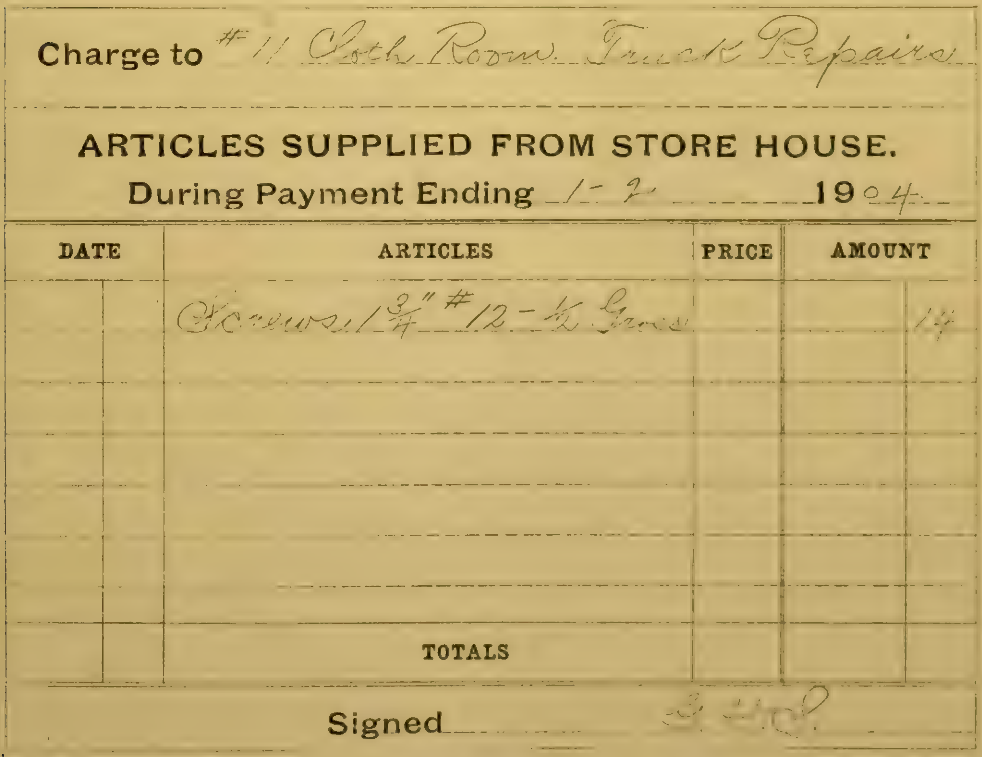
Stock and Labor on Repair Folder Rod Order No.

Date	Remarks	Stock	Time	Price	Cost
	Labor		1		
	Refined Iron	2			
	TOTALS				

Returned 1-5 1904 E. H. C. Foreman

FIG. 6. CHARGE SLIP.

The original is 5¼ inches wide and 4 inches high.



Charge to # 11 Cloth Room Truck Repairs

ARTICLES SUPPLIED FROM STORE HOUSE.

During Payment Ending 1-2 1904

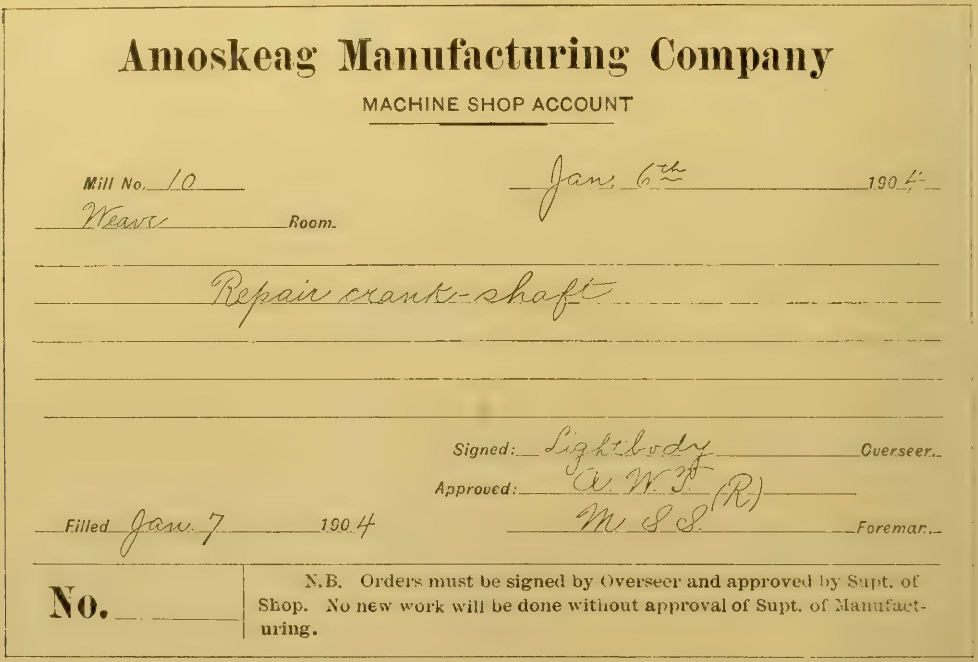
DATE		ARTICLES	PRICE	AMOUNT	
		Screws 1¾" #12 – ½ Gross			14
		TOTALS			

Signed

FIG. 7. STORE-HOUSE SUPPLY FORM.

The original is 5¼ inches wide and 4 inches high.

filed behind the proper index card in a card catalogue kept for this purpose. Stock charges are returned by foremen on charge slips showing the amount of stock used, in all cases where considerable amounts of bar stock are used from shop storage. When the amount used is small it may be entered on the time card of the workman to whom it was supplied. Castings used are charged by the clerks, the amount being copied from returned foundry orders and entered on charge slips. Foremen, both for stock and labor, return amounts only, all prices being affixed and values computed by the office clerks from lists kept for the purpose. Special stock and sundry supplies not kept on hand in the shop are ordered of or through the store house, and from this department returns are made of all articles supplied, and their cost, on a special form (Figure 7) which is of the same size as the charge slips and is filed with them. Most of the bolts, nuts, screws, studs, and certain small parts used in large quantities are made in special machinery in the bolt and screw department, all stock and labor used for such purposes being charged and accounted for as "stock." The cost of such articles being easily determined and very uniform, they are kept on hand in bulk and when supplied are charged from fixed price lists, the number and price being entered on the face of the order upon which they are delivered. All such orders are returned to the office and the entries transferred to charge slips. Figure 8 shows



Amoskeag Manufacturing Company

MACHINE SHOP ACCOUNT

Mill No. 10 Jan. 6th 1904

Weave Room.

Repair crank-shaft

Signed: Lightbody Overseer.

Approved: A. W. F. (R)

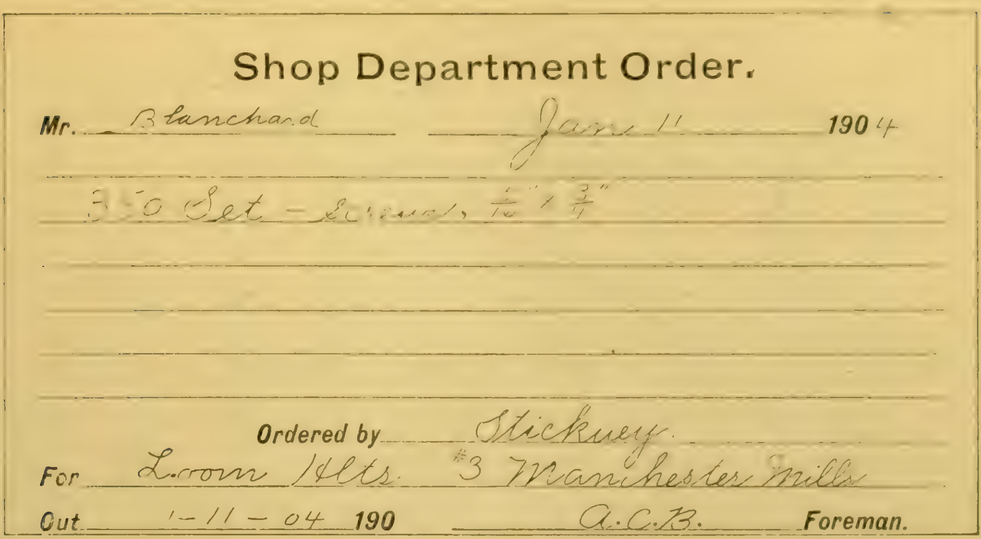
Filled Jan. 7 1904 M. S. S. Foreman.

No. ______

N.B. Orders must be signed by Overseer and approved by Supt. of Shop. No new work will be done without approval of Supt. of Manufacturing.

FIG. 8A. FOR MILL OVERSEERS' REPAIR ORDERS AT MACHINE SHOP.

The original is 8 inches wide and 5½ inches high.



Shop Department Order.

Mr. Blanchard Jan 11 1904

350 Set - Screws, 5/16" x 3/4"

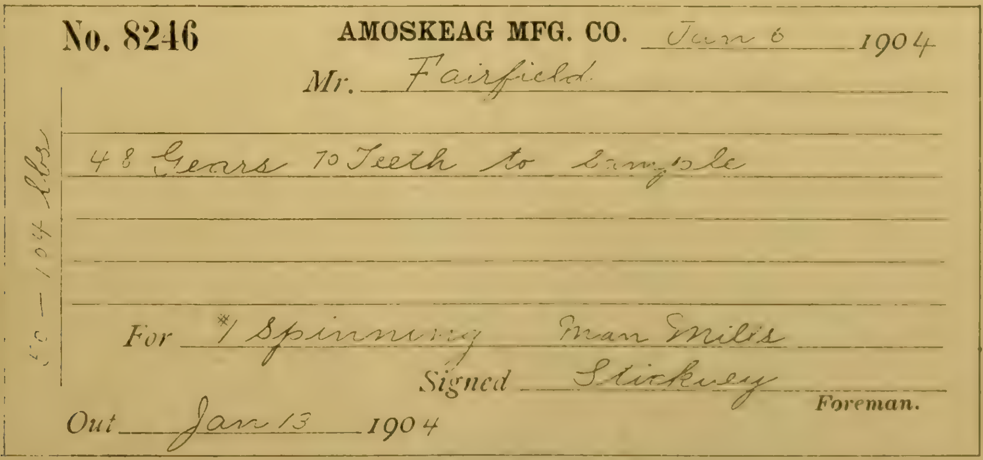
Ordered by Stickney.

For Loom Hlts. #3 Manchester Mills

Out 1-11-04 190 A.C.B. Foreman.

FIG. 8B. SHOP FOREMEN'S INTERCHANGE REPAIR ORDER.
The original is 5 inches wide and 2¾ inches high.

the order forms used (A) by the mill overseers in ordering repairs at the machine shop; (B) by the shop foremen in ordering work of each other; (C) by the shop foremen in ordering castings from the foundry. Form C provides a duplicate carbon copy, kept by the foremen for reference. Form C with duplicate and triplicate copies is used in the shop office, and when castings are ordered the original order goes to the foundry and the duplicate to the shop foreman who is to finish the work, and is equivalent to an order to finish it and a notification that the castings are ordered. Foundry orders, when the castings are all made, are returned to the foreman who finishes the castings with their number and weight entered on the face of the order. After the work is finished the orders are returned to the shop office and the weights transferred to the charge slips.



No. 8246 **AMOSKEAG MFG. CO.** Jan 6 1904

Mr. Fairfield

48 Gears 70 Teeth to Sample

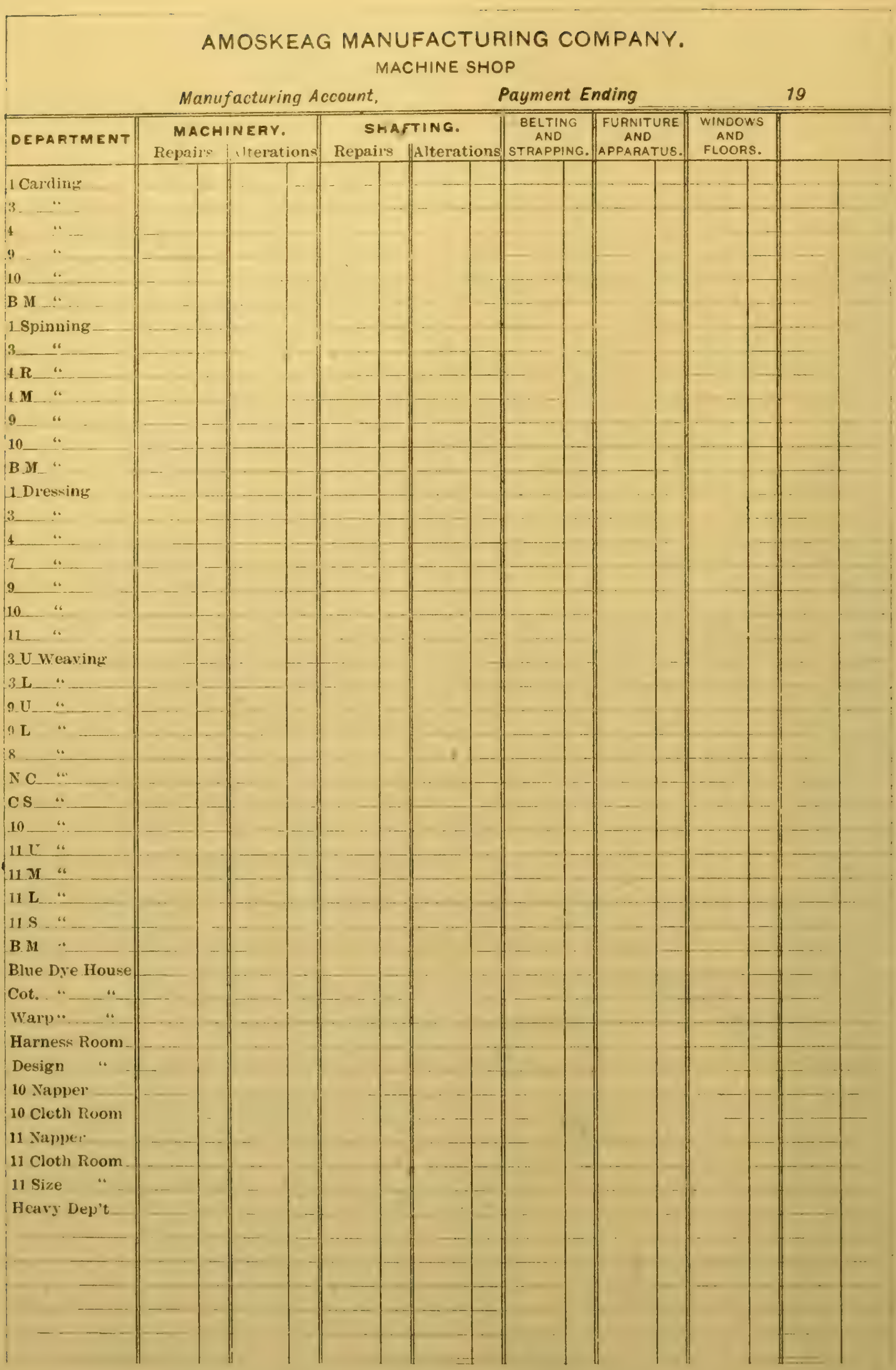
48 — 104 lbs

For #1 Spinning Man Mills

Signed Stickney Foreman.

Out Jan 13 1904

FIG. 8C. SHOP FOREMEN'S REPAIR ORDER FOR FOUNDRY WORK.
The original is 6 inches wide and 2¾ inches high.



AMOSKEAG MANUFACTURING COMPANY.

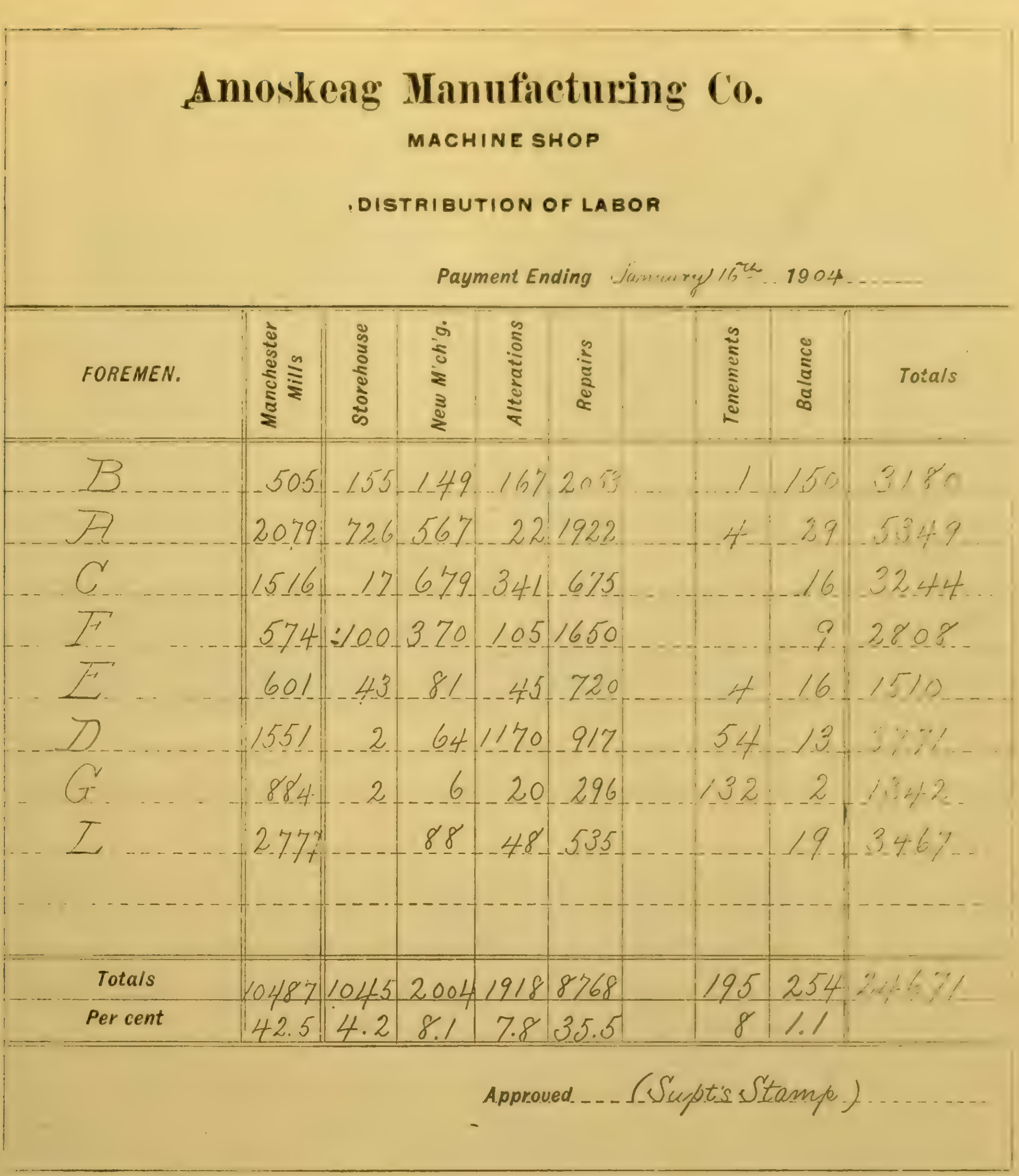
MACHINE SHOP

Manufacturing Account, *Payment Ending* 19

DEPARTMENT	MACHINERY.		SHAFTING.		BELTING AND STRAPPING.	FURNITURE AND APPARATUS.	WINDOWS AND FLOORS.	
	Repairs	Alterations	Repairs	Alterations				
1 Carding								
3 "								
4 "								
9 "								
10 "								
B M "								
1 Spinning								
3 "								
4 R "								
4 M "								
9 "								
10 "								
B M "								
1 Dressing								
3 "								
4 "								
7 "								
9 "								
10 "								
11 "								
3 U Weaving								
3 L "								
9 U "								
9 L "								
8 "								
N C "								
C S "								
10 "								
11 U "								
11 M "								
11 L "								
11 S "								
B M "								
Blue Dye House								
Cot. " "								
Warp " "								
Harness Room								
Design "								
10 Napper								
10 Cloth Room								
11 Napper								
11 Cloth Room								
11 Size "								
Heavy Dep't								

FIG. 9. MANUFACTURING REPORT.

The original is 8½ inches wide and 14 inches high, ruled in red.



Amoskeag Manufacturing Co.

MACHINE SHOP

DISTRIBUTION OF LABOR

Payment Ending January 16th 1904

FOREMEN.	Manchester Mills	Storehouse	New M'ch'g.	Alterations	Repairs		Tenements	Balance	Totals
B	505	155	149	167	2053		1	150	3180
A	2079	726	567	22	1922		4	29	5349
C	1516	17	679	341	675			16	3244
F	574	100	370	105	1650			9	2808
E	601	43	81	45	720		4	16	1510
D	1551	2	64	1170	917		54	13	3771
G	884	2	6	20	296		132	2	1342
I	2777		88	48	535			19	3467
Totals	10487	1045	2004	1918	8768		195	254	24671
Per cent	42.5	4.2	8.1	7.8	35.5		8	1.1	

Approved (Supt's Stamp)

FIG. 10. CLASSIFICATION OF LABOR FOR DISTRIBUTION OF LABOR REPORT.

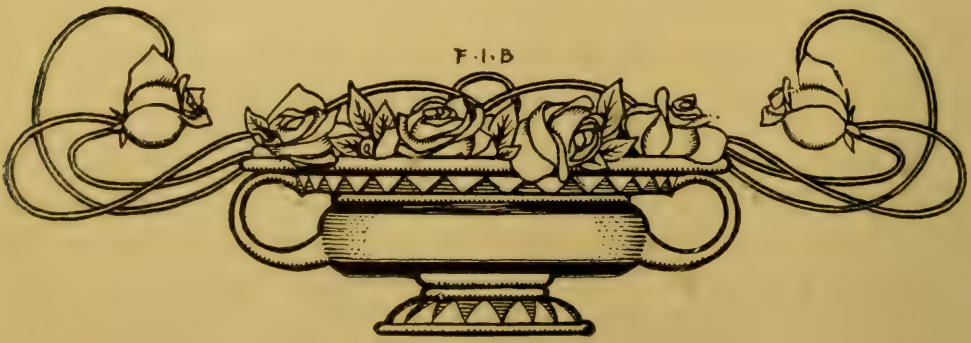
The original is 8 inches wide and 9 inches high.

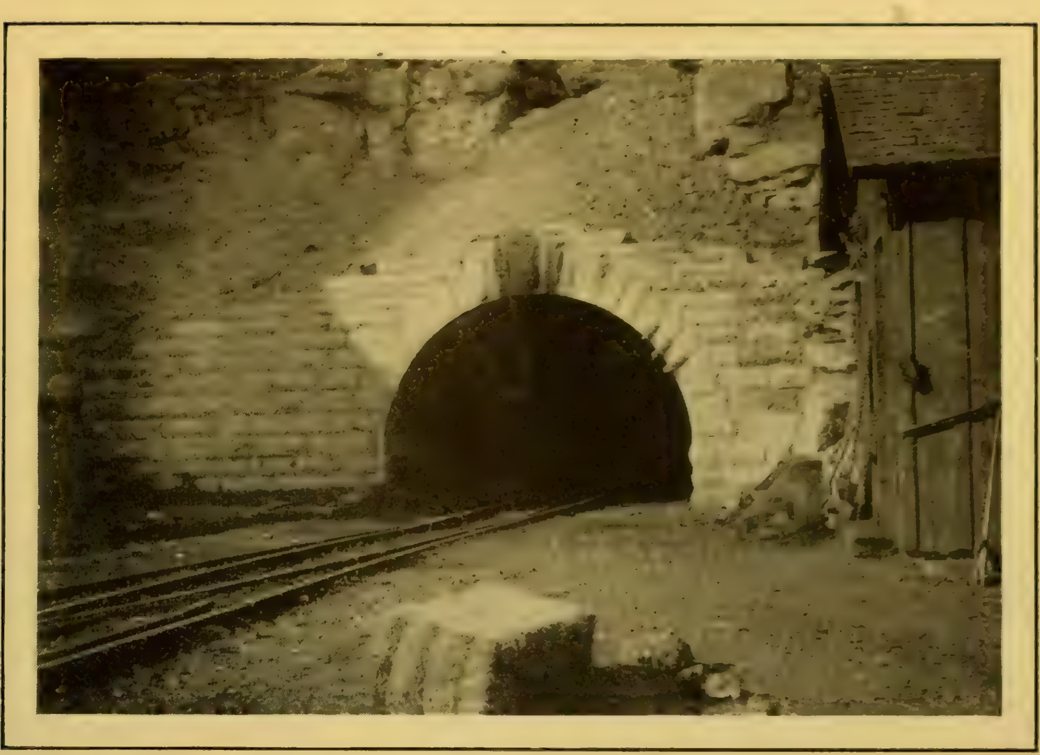
At the end of each payment, after all charges are transferred, the manufacturing reports are made out. Figure 9 shows the form used for the Amoskeag Company, which is similar to those for the Manchester Mills and Print Works. The amounts shown on these reports are the totals shown by the charge slips, as an itemized account would be undesirably voluminous. The charge slips, however, are preserved for several weeks for reference in case of questions arising as to details. The reports are sent to the manufacturing superintendents of each mill. Reports of the cost of repairs pertaining to the power plant and other reports of a special nature are compiled in the same way and returned to the general superintendent and certain other officials.

To prepare the "Distribution of Labor" report the charge slips are re-sorted, and the labor shown by them for all the large departments is divided according to the classification indicated on the form shown in Figure 10. When completed this report shows the work of each class done, in hours of labor, in each department, and the relative amount of labor required for each class expressed as a percentage of the whole. The utility of this report is not perhaps apparent to the casual observer; but ccupled with a knowledge of the demand for work of each class, and the state of completion, it is of great use to the management in planning the distribution of work and help. For example: if an important alteration job is about to be undertaken, we can judge very well from what class of work all or part of the necessary help can be taken, and from what departments they can best be spared without interfering too seriously with some other class of work which, for the time being, may be equally important.

It will be noted that the Manchester Mills labor is shown in a class by itself on this report; but it appears, divided according to the same classification, on a second report which is sent to the Manchester Mills management.

Such, in brief, is the cost-keeping and shop-statistics system of the Amoskeag mills. A following article in the next issue of this Magazine will explain the method of adapting the premium plan of wage payment to the conditions of the work, and the forms and blanks used in its administration.





A MINE ENTRANCE, POCAHONTAS, VIRGINIA.

COALS AND COAL-MINING METHODS OF THE POCAHONTAS FIELD.

By Geo. L. Fowler.

Mr. Fowler's interesting account of the geological and mining features of the Pocahontas region will be followed by a second taking up the economic aspects of the field.—The Editors.

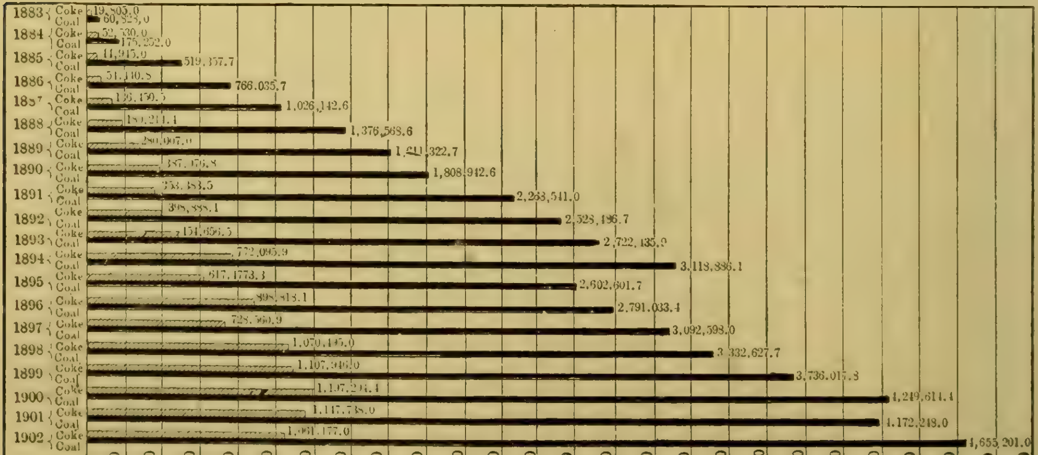
THE saying that a truly good thing will surely be appreciated. coupled with the one of perhaps doubtful truth, that "all things come to him who waits," has been fully sustained by the history of the success that has attended the exploitation and development of what is known as the Pocahontas coal.

The field is situated on the border line between Virginia and West Virginia, slightly overlapping into and extending over parts of Tazewell and Buchanan counties in the former State, but located for the most part in the counties of McDowell, Wyoming, and Mercer in the latter. It includes about 450 square miles of rough mountain land, unsurpassed for scenic beauty and consisting of a succession of ridges rising from 200 to 800 feet above the streams, which themselves flow at an elevation of about 2,000 feet above the sea.

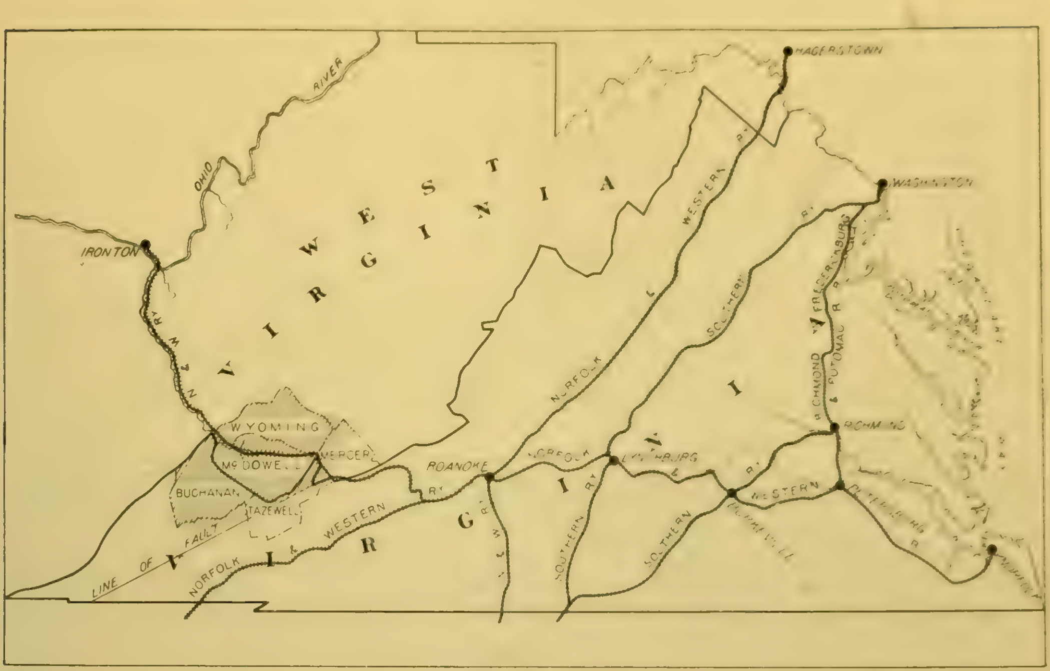
It was in 1882 that the first mine in the vein now known by the name was opened at the village of Pocahontas, in Tazewell Co., Virginia. The locality has thus given its name to the region and its product. In the first year the output amounted to but 60,828 gross tons, and though in the second year two new operations were opened, and the total output was increased to 175,252 gross tons, the introduction of the new coal to the markets of the eastern States was both slow and discouraging, so that for a time the operators were sorely tempted to abandon the venture. There was no possibility of reaching the western market, as the Norfolk and Western Railway had been built into the mountains from the east only, and so little was known of the field, and it was thought to be so limited in extent, that capitalists in some cases refused to so much as to investigate the coal lands. The completion of the railroad through to the west was a mere scheme, laid out over a route down Piney Creek which was afterwards abandoned, the construction being carried down the valleys of the Elkhorn Creek and the Tug River.

So with comparatively poor means of transportation, with limited capital, and with but little experience, it was a difficult piece of work to introduce this new grade of coal into a market already devoted to the use of Pennsylvania anthracite and bituminous coal. The article was, however, of such a character that after its merits had once been appreciated, the demand increased by leaps and bounds, and the first mine (whose output was 60,828 tons in 1882) touched its high-water mark at 705,333 tons in 1888.

The reason for the later falling off in the output of this particular



GRAPHICAL ILLUSTRATION OF COAL AND COKE SHIPMENTS FROM THE POCAHONTAS FIELD.

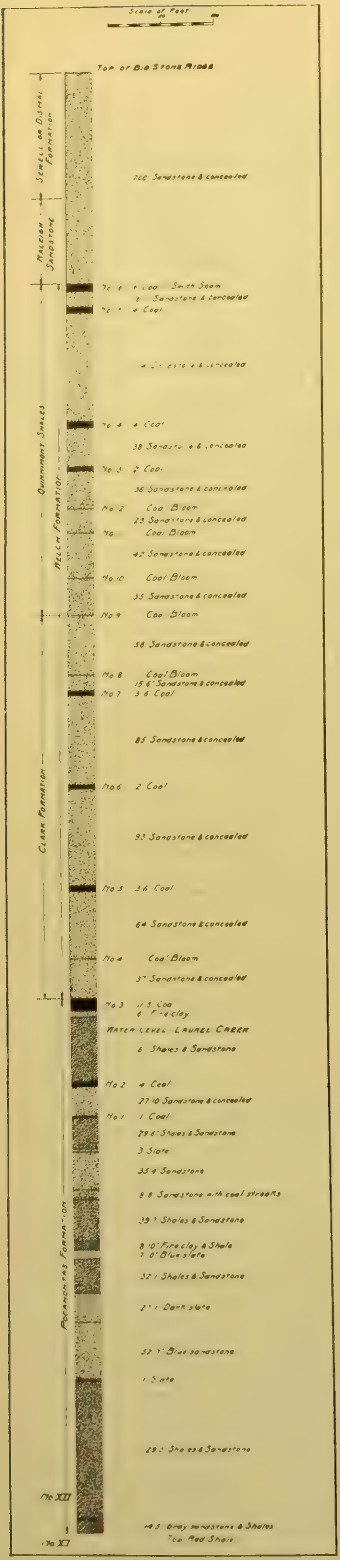


MAP OF VIRGINIA AND WEST VIRGINIA, SHOWING THE LOCATION OF THE POCAHONTAS COALFIELD AND THE RAILWAYS AFFORDING TRANSPORTATION FACILITIES.

mine is two-fold. The principal difficulty of holding it at this high figure is due to the rapid development of other operations in the field, which grew more rapidly than the facilities of the railway company, and as each operation is entitled to a fixed percentage of the equipment, the shortage of rolling stock had the effect of curtailing the output. The other, though minor cause, is the fact of the increased haulage required in the mines in later years, whereas in the early days the mining was done nearer the outcrop at the surface. It is, therefore, probable that if the railway facilities had increased in proportion to the operations, the one mentioned would not have reached its high-water mark in 1888.

As more extensive surveys were made and the true area of the field was ascertained, capital was more than eager to invest in the lands, until now nearly the whole is under the control of large and wealthy corporations. In order to convey an idea of the growth of the industry the accompanying graphical chart has been prepared.

With this brief review of the growth of the industry, let us now turn to the reason therefor. It may be truly said to be due entirely to the quality of the goods offered to the consumer. Handicapped as it was by its location and the excessive transportation charges which it had to meet—charges that obtained whether it were offered in the eastern or western markets—its use depended upon its superiority, and on this alone it has won its present position.



TYPICAL GEOLOGICAL SECTION, POCAHONTAS COALFIELD

The main vein is known as the Pocahontas No. 3. It will be seen by a reference to the typical geological section of the field that the coal measure upon which the wealth of the region is based is among the lower of the coal formations of the district, and is about 870 feet below the top of the Big Stone Ridge; it lies immediately over a bed of fire-clay, resting upon a stratum of shale, and buried beneath hundreds of feet of sandstone that is always closely associated with the coal measures, and about 2,000 feet above the limestone, a fault in which brings the field to an abrupt termination on the south-eastern border. This fault undoubtedly lifted the carboniferous strata with the superincumbent sandstones, all of which have been eroded by the countless æons that have passed since they were displaced. Traces of the coal measures, however, are still found in isolated places to the eastward, showing that in all probability they once extended to the ancient seashore on the eastern slope of the Blue-ridge Mountains. It is probable, too, that these eastern beds were thicker than those now being worked, as the veins exhibit a constant tendency to thicken in that direction. To quote from the recent report of the West Virginia Geological Survey:

> "The entire thickness of the rocks in the Carboniferous system varies much in different portions of the State. In a general way the several series composing the system thicken eastward, gradually in the northern portion, but very rapidly in the southeastern region. This gives a rapid thickening southwestward along the western flanks of the Alleghany mountain range."

It will be seen from the vertical section that the major portion of the upper measures are very thin and not workable. Most of these have been eroded from the territory of the Pocahontas field and appear to the west under other names, and thus fall outside the province of this article. It may be merely mentioned in passing that the most important of these to West Virginia is the Thacker vein, shown as No. 5 on the section. The thickness of this is given as 3 feet 6 inches, which sinks to comparative insignificance beside the 11 feet 3 inches of the great Pocahontas vein No. 3. In referring to this section it must not be understood that it actually exists as shown in the engraving on the Pocahontas field. This is a typical geological section. As a matter of fact, in the field itself there is not cover enough overlying the No. 3 vein to hold the higher measures, but in moving down the Elkhorn in the direction of the Tug River the Pocahontas vein finally drops down below water level, and then as it passes beneath the mountains on the west, they admit of the overlying coals coming in; these, in turn, as they go to the northwest gradually go down to the water level and also disappear. Between the Pocahontas coal measures and the Thacker measures there is a large area made up of heavy sandstone, which is known as the "Run of the Tug" and indicates a barren period between the two. This barren period comes in on top of the Pocahontas coal. The Thacker vein is younger, contains more volatile matter and bitumen, and consequently gives off a heavy smoke.

AN OUTCROP OF COAL AT POCAHONTAS.

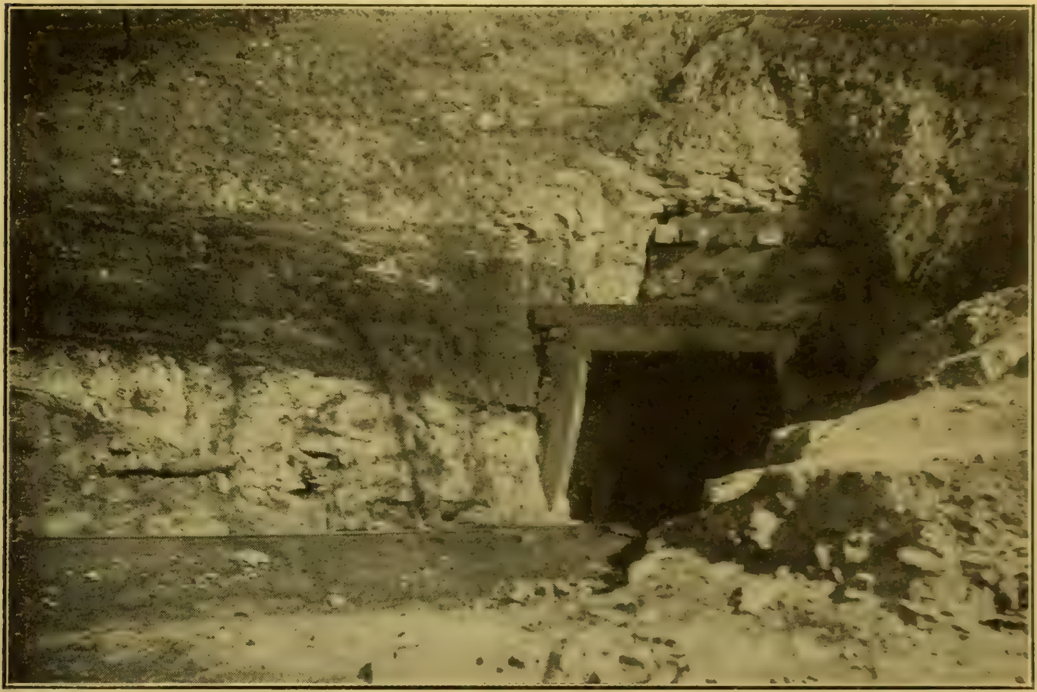
The peculiarity of the Pocahontas coal is to be found in its low content of ash and volatile matter, as well as of sulphur and other impurities, and the resultant high percentage of fixed carbon with the high calorific value that follows upon such conditions. The Pocahontas vein is thought to correspond to the anthracite vein of red-ash coal of the Lykens Valley near Pottsville, Pa. The geological explanation of the difference is that the anthracite bed was subjected to a more thorough coking process under pressure than the Pocahontas portion of the vein, while the latter owes its own lack of volatile matter to the fact that it was subjected to heat under pressure for a more protracted period than the bituminous coals of western Pennsylvania and Ohio. Just what this process actually was, geologists are as yet by no means positive, beyond the bare outline that has been given.

In order that the comparative value of this fuel with others may be understood the following analyses are given:—

Proximate Analyses and Heating Values of Some American Coals.

Coal.	Moisture.	Volatile Matter.	Fixed Carbon.	Ash.	Sulphur.	Heating Value per lb. B.T.U.	Relative Heating Value Based on Pocahontas 100.
Anthracite:							
Southern Field, Pa..	3.09	4.28	83.81	8.18	.64	13,220	88.
Semi-anthracite:							
Bernice Basin	.65	9.40	83.69	5.34	.91	13,700	91.
Semi-bituminous:							
Clearfield Co., Pa...	.76	22.52	71.82	3.99	.91	14,950	99.
Cumberland, Md. ..	1.09	17.30	73.12	7.75	.74	14,400	96.
Pocahontas, Va. ...	1.00	21.00	74.39	3.03	.58	15,070	100.
Bituminous:							
Connellsville, Pa. ...	1.26	30.12	59.61	8.23	.78	14,050	93.
Pittsburg, Pa.	1.37	35.90	52.21	8.02	1.80	13,410	89.
Thacker, W. Va....	1.38	35.04	56.03	6.27	1.28	14,040	93.
Hocking Valley, O..	6.59	34.97	48.85	8.00	1.59	12,130	81.
Scott Co., Tenn.....	1.26	35.76	53.14	8.02	1.80	13,700	91.
Jefferson Co., Ala...	1.55	34.44	59.77	2.62	1.42	13,770	91.
Big Muddy, Ill.....	7.50	30.70	53.80	8.00		12,420	82.
Mt. Oliver, Ill......	11.00	35.65	37.10	13.00		10,490	69.
Missouri	6.44	37.57	47.94	8.05		12,230	81.
Lignite:							
Iowa	8.45	37.09	35.60	18.86		8,720	58.
Utah	9.29	41.97	44.37	3.20	1.18	11,030	73.

Setting aside the anthracite and semi-anthracites, the superiority of the Pocahontas semi-bituminous coal is clearly recognizable. Its only rivals are the Clearfield and Cumberland coals, and these not only fall below it in the amount of fixed carbon, but rise above it in the quantity of ash, the Cumberland coal alone falling below it in the percentage of volatile matter. And in freedom from sulphur it outstrips all others. With these qualities it naturally follows that it stands highest in calorific value, though pressed within a small percentage by the rivals already mentioned.



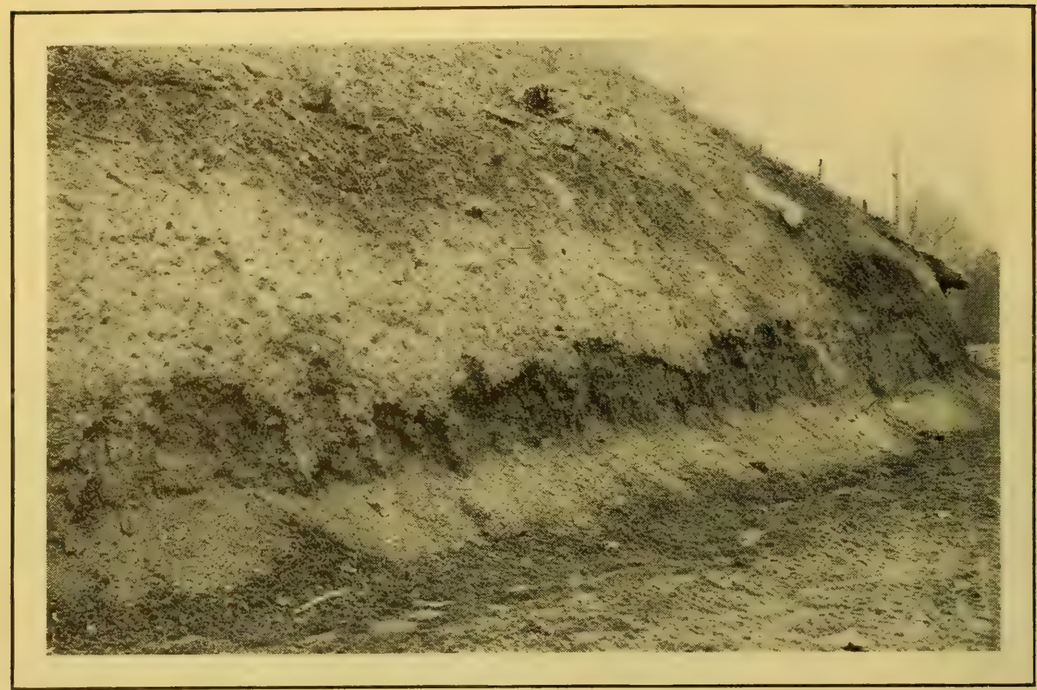
MINE OPENING, SHOWING THE OUTCROP, ENNIS, WEST VIRGINIA.

It should be borne in mind that this refers to these coals in their palmy days, when the thicker vein of the Cumberland was being worked; for since this has been to an extent exhausted and the thin overlying one is being mined, Cumberland coal has lost much of its early standing. The same statement practically holds true of the Clearfield also. Another comparison with similar coal is given below taken from calorimeter and boiler tests and a theoretical calculation.

RELATIVE VALUE OF COALS.

Hocking = 100.

Coal.	Calorimeter Test.	Boiler Test.	Calculated Evaporation Value.
Hocking	100	100	100
Pocahontas	122	127	131
Thacker	116	117	116
Freeport	109	106	109
Darling	112	105	109
Pittsburg	113	113	114



OUTCROP ON A TRAMWAY LINE NEAR THE MAIN OPENING, NO. 7 MINE.

All of which merely goes to show that the Pocahontas is what it is claimed for it—one of the best steam coals, if not the best of the world.

It may be stated that the analysis of the Pocahontas coal as given in this table is the average of three analyses, made of the coal taken from three different points in each of the mines of the territory, by a disinterested party who was considering the advisability of using Pocahontas coke for metallurgical purposes. The result was that it was so adopted. In this connection it should be definitely understood that the analysis given is an average and represents neither the best nor the poorest samples. In some instances the sulphur rose to 1.42 per cent. and in others it dropped to 0.25 per cent., while the calorific value in one instance was 15,782 thermal units.

The vein, too, is not always of the same thickness, but varies, becoming thinner towards the edge of the territory, dropping down from a maximum of 11 feet at the center to 4 feet or less at the edges. Sometimes this occurs as the result of a split, where a wedge-shaped mass of shale is thrust into the body of the coal, deflecting the upper portion from the main section upward at the rate of about 20 feet to the mile.

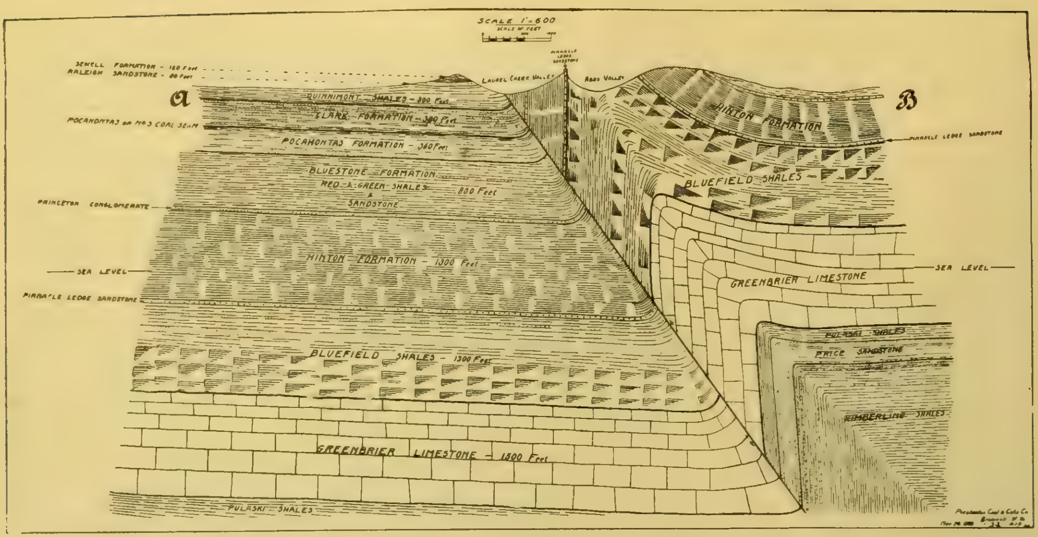
This thinning of the vein has an apparent influence upon the content of volatile matter, in that the quantity decreases with the thickness. This adds another argument in favor of the coking theory of its formation, in the probability that it was more difficult, with an equal application of heat for equal periods of time, to coke the thick masses than it was the thin, with the result that the former still retain the higher percentage of volatile matter.

Pure and of as high a grade as the coal is, the seam carries two thin streaks of impurities. They are from one to two inches in thickness and are known as the bone and sulphur bands. The former is merely a low grade of coal, high in ash and difficult to burn, but still quite possible to use in an ordinary furnace, though its calorific power is necessarily low. The sulphur vein is an entire misnomer. There is no sulphur in it whatever, but it is an exceedingly hard sandstone that will not melt in an ordinary fire, but when the latter is forced a clinker will sometimes form from a substance that has not yet been clearly determined. This does not occur regularly, but only occasionally, which indicates that the impurity is not present at all times in the vein, for, if it were, it would soon be detected and determined.

The area occupied by the seam under consideration is defined upon the map, but in reading this it must be understood that as the dip is to the north about 40 degrees west, the limits of the stratum in that direction have not been determined. On the southeast the seam comes to an abrupt termination on account of a fault in the rocks. This fault runs in practically a straight line northeast and southwest down the Clinch Valley division of the Norfolk and Western Railway, having the Clinch River as a dividing line, with limestone on the east and some of the coal measures on the west. It passes just to the east of Lookout Mountain in Tennessee, and is caused by the elevation of the limestone that lies beneath the sandstone underlying the coals, which is itself 1,100 feet thick, so that to the east of the fault the limestone is about 2,000 feet above its normal position, and in its rise it has carried the coal seams with it and along the edge has turned the main Pocahontas No. 3 seam so that it is vertical.

This same fault is observed at Cumberland Gap, with the limestone measures on the east and the Middlesboro coals on the west. Beyond Lookout mountain it runs down into the Birmingham field, and ends at a point that has not yet been located.

The distortion that was caused by this elevation is clearly shown by the geological cross section of the Abbs Valley fault. The actual break is quite as distinctly marked as that shown in the engraving, and the resistance to the upward movement of the strata lying to the east at the point of fault is shown by the turning of the same into that


SCALE 1' = 600
SCALE OF FEET
SEWELL FORMATION - 120 Feet
RALEIGH SANDSTONE - 80 Feet
a
QUINNIMONT SHALES - 800 Feet
CLARK FORMATION - 300 Feet
POCAHONTAS OR NO 3 COAL SEAM
POCAHONTAS FORMATION - 360 Feet
BLUESTONE FORMATION
RED & GREEN SHALES & SANDSTONE
800 Feet
PRINCETON CONGLOMERATE
HINTON FORMATION - 1300 Feet
SEA LEVEL
PINNACLE LEDGE SANDSTONE
BLUEFIELD SHALES - 1300 Feet
GREENBRIER LIMESTONE - 1800 Feet
PULASKI SHALES
LAUREL CREEK VALLEY
PINNACLE LEDGE SANDSTONE
ABBS VALLEY
B
HINTON FORMATION
PINNACLE LEDGE SANDSTONE
BLUEFIELD SHALES
SEA LEVEL
GREENBRIER LIMESTONE
PULASKI SHALES
PRICE SANDSTONE
KIMBERLING SHALES
Pocahontas Coal & Coke Co.

GEOLOGICAL CROSS SECTION, SHOWING THE ABBS VALLEY FAULT.

vertical line already noted. Beyond the line of fault the coal and upper strata have been for the most part eroded, though traces of them can be found in places. The thickness of the seam varies from 6 to 11 feet, and the coal is so free from gas that safety lamps are not used in the mines and are only held for use in cases of emergency.

The common method of mining heretofore used is the double-entry system with rooms driven off opposite each other at right angles to the main entries or headings. The accompanying engraving shows a typical mine working that has been developed along these lines. In the first place the two parallel entries are started in from the outcrop. They are 10 feet wide with a pillar of coal 50 feet wide between them. As they advance artificial ventilation becomes necessary, and at intervals of 100 feet or so the break-throughs are cut. The laws of West Virginia now require that these shall not be more than 100 feet apart, though formerly they were spaced at much greater distances than this, being, in fact, cut only when the miners felt the need of fresh air. The ventilation is almost invariably accomplished by means of an exhaust fan placed over an opening in the outcrop, and in this typical plan, it is placed at the opening of one of the entries. If unimpeded, the natural flow of the air would be in at one entry, across to the other by way of the first break-through, and thence back to the fan. Such a state of affairs would leave both entries—and in fact the whole mine beyond the first break-through—without any ventilation. This condition is met by placing a stop or brattice in each successive break-through, leaving only the last one open to the draft. The result is that there is a powerful air current passing in at one entry, moving down it to the last break-through, and thence back. Under these conditions the rooms that are cut out at right angles obtain their ventilation by diffusion. Sometimes the rooms or entries are carried through to the outcrop and this distant opening is made to serve as the intake for fresh air. In that case a door is placed across one of the entries, by which the influx of air is cut off except when opened for the passage of a car or train.

The course of the ventilation in a secondary mine is also shown, where there are the two main entries from one of which two or more are driven off at right angles to one of the former. This is then stopped between the two and the air current made to follow the long and devious course to the very depths of the mine as indicated by the arrows. Where the rooms of the two mines are run together their ventilating currents are separated by brattices.

The fans that are used for this ventilation are from 25 feet to 40 feet in diameter, with a capacity of 300,000 to 500,000 cubic feet of air per minute, and are driven either by an individual steam engine or an electric motor, dependent upon the location. If they are near the central power house and within easy reach of steam, engines are used; but if they are over a distant opening in the outcrop, as in the illustration, they are driven by electricity.

The rooms that are led out from the entries on either side are

VENTILATING-FAN HOUSE, POCAHONTAS, VIRGINIA.

spaced about 60 feet apart between centers. They are driven from 18 to 20 feet in width, with an entering neck 10 feet wide, thus leaving a supporting pillar between them from 40 feet to 42 feet thick. Here timbering is sometimes used in the form of props set from 6 feet to 8 feet apart on the gob or off side, leaving room for the track next the main wall. The main body of the room widens to 18 feet immediately back of this. The object is to retain as large a body of coal as possible along the entries to protect them from the effects of any squeezing due to the yielding of the coal beneath the superincumbent rocks. The character of the overlying strata is such that for the width of entries and rooms here used, no timbering is needed, except that just specified.

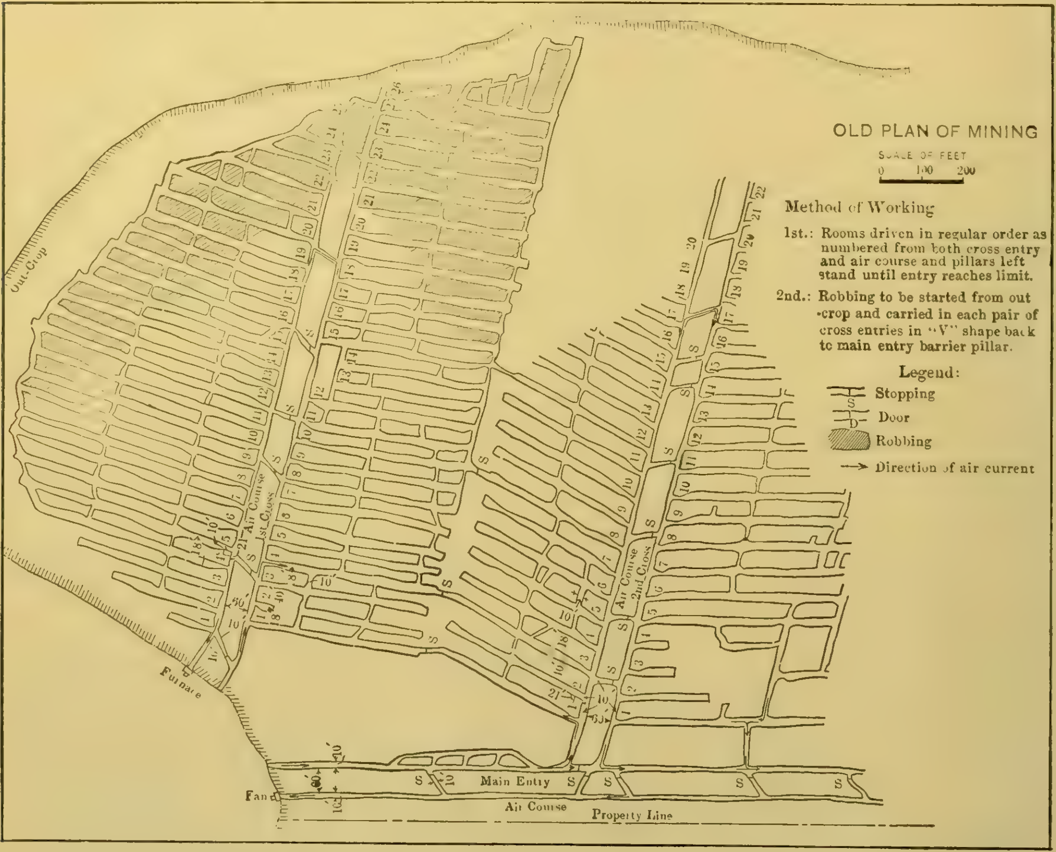

OLD PLAN OF MINING
SCALE OF FEET
0 100 200
Method of Working
1st.: Rooms driven in regular order as numbered from both cross entry and air course and pillars left stand until entry reaches limit.
2nd.: Robbing to be started from out-crop and carried in each pair of cross entries in "V" shape back to main entry barrier pillar.
Legend:
Stopping
Door
Robbing
Direction of air current
Out-Crop
Furnace
Fan
Main Entry
Air Course
Property Line
1st Cross
Air Course
2nd Cross
Air Course

DIAGRAM ILLUSTRATIVE OF OLD SYSTEM OF MINING.

After the mine has been blocked out a systematic robbing of the pillars is begun, as indicated by the hatched section of the engraving. The work is begun at the farthermost corners of the mine and the pillars are cut away in a V formation, working back towards the main entries. Theoretically this should make it possible to obtain all of the coal, but as a matter of fact squeezing is apt to run ahead of a cave-in of the roof, whereby a considerable section of coal is crushed and mingled with the débris from above and thus lost.

As the pillars are robbed the roof naturally falls in, but it is of such a character that it falls piecemeal and arches over, the loose pieces filling the whole space beneath, and in this way the upper surface of the ground is not often disturbed except by the loss of the water from a well or the disappearance of a stream, though, of course, surface subsidences do occur.

In order to avoid this waste of coal due to squeezing following upon the robbing of the pillars, a modification of the double-entry system has been introduced. A typical plan of a mine worked out along these new lines is shown in the engraving, and is known as the panel system.

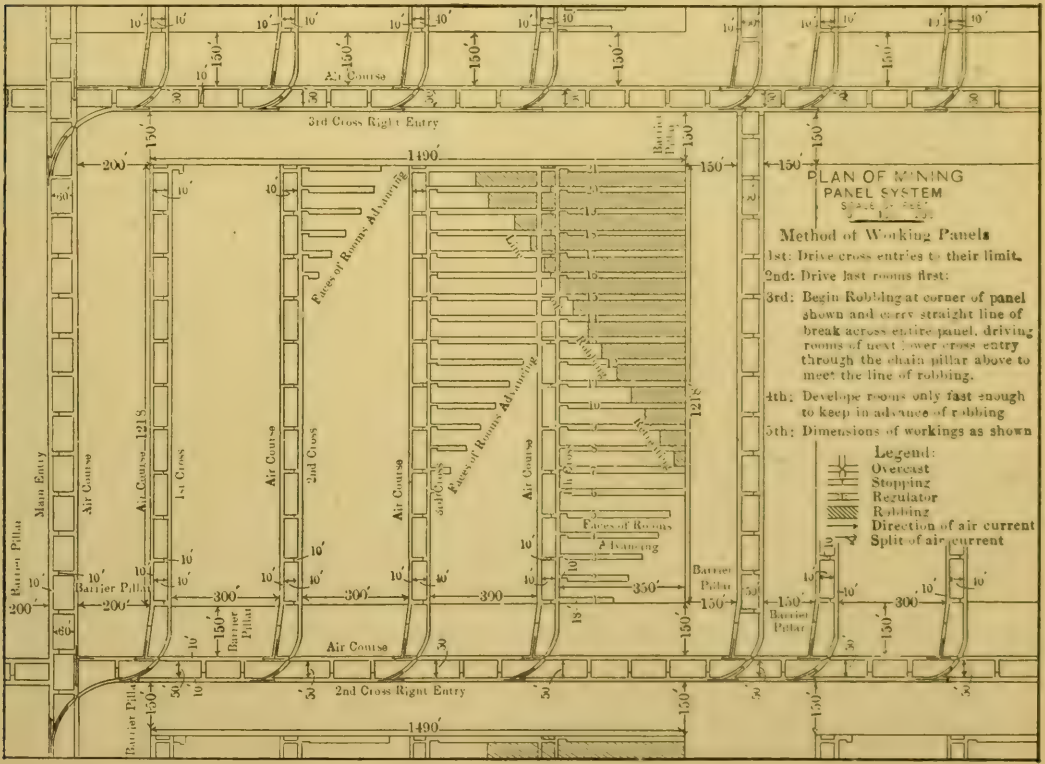

PLAN OF MINING
PANEL SYSTEM
Method of Working Panels
1st: Drive cross entries to their limit.
2nd: Drive last rooms first:
3rd: Begin Robbing at corner of panel shown and carry straight line of break across entire panel, driving rooms of next lower cross entry through the chain pillar above to meet the line of robbing.
4th: Develope rooms only fast enough to keep in advance of robbing
5th: Dimensions of workings as shown
Legend:
Overcast
Stopping
Regulator
Robbing
Direction of air current
Split of air current
3rd Cross Right Entry
2nd Cross Right Entry
Air Course
Main Entry
Barrier Pillar
1st Cross
2nd Cross
3rd Cross
4th Cross
Faces of Rooms Advancing
1490'
1218
300'
200'
150'
10'

DIAGRAM SHOWING NEW SYSTEM OF MINING.

There are the same entries with 50 feet of coal between them as before; but instead of leading the rooms directly off from these, they are flanked on either side by a barrier pillar 150 feet wide to carry the roof and maintain the integrity of the entries until the end, while the rooms are driven off from subsidiary or cross entries.

The method of working is to drive the cross entries to their limit, with the necessary break-throughs, thus forming what is known as a chain pillar. When this has been done the last room is driven first, and pillar robbing is begun at once as indicated by the hatchings. In this way it will be seen that there is always a large body of coal coming up to the robbing line, and this will have sufficient strength to carry the roof and prevent that squeezing which is so wasteful of the coal. The ventilation of the new system is the same as that of the old and the course of the air currents is clearly indicated by the arrows on the plan.

As this coal is so free from gas that the safety lamp is not needed and that open lamps are used, and as the location of the vein is well upon the hillside, the mining operations are comparatively simple. In only a few instances are mining machines used. The under cutting is done by hand, the miner starting in with a height of about 18 inches and working back for about 6 feet, where he will have a height of 6 inches. A powder blast is then exploded overhead and the mass blown down. It is loaded into cars and the miner is paid by the carload. Tracks are run into the rooms from the main entries and the cars are hauled out by either electric or steam locomotives, though the latter are used in the majority of cases. In a few instances the electric motors are fitted with a cable by which they can maintain connection with the main wire while working in and out of the rooms.

The cars are simple four-wheeled lorries with a swinging end door permitting the whole car to be tilted and dumped at the tipple. This whole mechanism is of the simplest design but answers its purpose most admirably. The cars as they are hauled out from the mine are left on a siding, from which they can be dropped down by gravity one at a time to the upper floor of the tipple to be dumped. This done, they run by gravity back onto another siding where they are coupled in trains to be taken back to the mines. The coal dumped from the cars falls into pockets, from the bottom of which chutes carry it to the cars in which it is taken to market.

Inspection begins in the mines, where the miner is required to pick out all of the bone and sulphur band and gob the same in the rooms. Then, as the coal runs from the chutes into the cars, there is a second careful inspection and every piece to which any bone or sulphur (sandstone) is adhering is picked out and thrown aside, so that the coal leaves for the market in first-class condition. It is this inspection, which is exceedingly rigid, that accounts for much of the high reputation of the Pocahontas coal.

Efforts have been made at various times to design a machine to separate this bone and sulphur (sandstone) from the pure coal, and the indications are that one will soon be in active and successful opera-

A MINE TIPPLE, POCAHONTAS, VIRGINIA.

tion; then hand picking will come to an end. Meanwhile some operators are considering the advisability of introducing pickers at the chutes before the coal reaches the hoppers, in accordance with the current practice at the anthracite coal breakers.

There is comparatively little machinery in one of these tipples, and until a few months ago, with the one exception of that at the Gilliam colliery on the North Fork Branch, they were invariably built of wood. This Gilliam tipple is of steel and was built about eight years ago, and recently a second structure of the kind has been put into operation at Elkhorn, West Virginia, and another is in course of construction at Pocahontas. There is usually an elevator for raising fine material, but the principal elements consist of an upper dumping floor; screens upon which the coal falls direct from the mine cars, and by which it is screened and sorted according to size; hoppers in which the coal is temporarily stored previous to loading, and chutes by which it is loaded into the railway cars.

Turning now for a brief review of the extent of the industry we find that in the first year, 1882, the output from the single operation that had been opened was 60,828 tons. The next year two operations were added and their total output was 175,252 tons. From that time on the growth has been rapid, new operations coming in constantly

NORFOLK & WESTERN RAILWAY 100,000-POUND CAPACITY COKE CAR.

and old ones adding to their facilities, until at the end of 1902 there were forty-eight at work with an annual output of 4,655,210 tons.

All this coal is hauled to the eastern and western markets by the Norfolk & Western Railway, whose policy has been one of liberal encouragement. Spurs have been led off from the main line at innumerable points so that the high-capacity cars of the railroad can be run directly to the mines for loading. In this, too, the railroad has been in the van in the introduction of large locomotives and cars.

It was amongst the first to realize the economic value of cars of 80,000 and 100,000-pounds capacity. Within the past two years important works of improvement have been undertaken, in the elimination of curves in the mountain section of the line and the establishment of large receiving yards at points where the traffic originates. These yards have been planned with the utmost care and stand as models of this class of work. That at Bluefield, which is the receiving, weighing, and distributing point for a large section of the Pocahontas field, will have, on the completion of the present work of enlargement, a length of nearly five miles and a capacity of 3,500 cars.

Here the cars are received, sorted, and started east over a line where every grade has been studied to a nicety and such a system of pushing and helping engines introduced that each locomotive is working to its maximum efficiency over the whole distance of 364 miles to the sea. Norfolk, Va., is the tide-water terminal, and here are large docks with steel trestles and chutes from which the coal may be loaded into vessels at the rate of twenty carloads, or 1,000 tons, per hour.

BOILER DESIGN AND BOILER EXPLOSIONS.

By R. S. Hale.

Mr. Hale is engineer to the Mutual Boiler Insurance Company. His paper is therefore the fruit of specialized study, supported by the enormous fund of information supplied by special facilities. It is a systematic and comprehensive analysis, valuable alike to the maker or the user of steam boilers.—THE EDITORS.

IN designing a new boiler, or in determining the permissible safe pressure on an old boiler, it is customary to make detailed calculations as to the strength of the important parts. In these calculations the most important term is always either a "factor of safety," as in the case of boiler shells, where the "factor of safety" is usually taken as about 5, or a "safe working stress," as in the case of boiler braces, where the "safe working stress" is usually taken at about 8,000 pounds per square inch. It is obvious that these two modes of expression really represent the same thing. We take the strength of the metal of which the boiler is made as 60,000 pounds per square inch, so that "a factor of safety of 5" is the same thing as a "working stress of 12,000 pounds per square inch," or on the other hand the "working stress of 8,000 pounds per square inch" on iron used for braces of 48,000 pounds ultimate strength per square inch is a "factor of safety of 6." In both cases the figures are determined solely by long experience, since there is no known method by which we can calculate from experiments what is a safe working stress or proper factor of safety.

Since the terms factor of safety and safe working stress are thus seen to be interchangeable, it should be noted that the term factor of safety is a complicated and often a misleading term. It means merely that the safe working stress as found by experience is some particular fraction of the ultimate strength, the ultimate strength being found in some particular way. For instance, the ultimate strength is usually taken from experiments on small sized test pieces, so that in wooden beams the factor of safety if based on the ultimate strength of the small test piece may be taken as, say, 8. Some famous experiments were once made in which the ultimate strength of large wooden test pieces showed a much lower ultimate breaking stress than was exhibited by small test pieces, but the only result of these experiments was to show that the factor of safety based on the tests of the large pieces could safely be made about 4, while if the factor of safety was based on the small test pieces it should be 8. In other words, designers considered that the safe working stress remained the same whether the large test pieces were used at a factor of 4, or the small test pieces with a factor of 8.

Iron beams show a similar case, though in the case of iron, tests of full sized beams show much greater ultimate strength than the breaking stress as figured from small test pieces. The factor of safety of an iron beam is something like 6 or 8 if figured on experiments on full sized beams, but the safe working stress is found in practice to be the same as when the beam is designed with a factor of safety of 4 figured on the ultimate strength of a small test piece.

This is as it should be, for as stated above, the present designs of beams and boilers, and working stresses or factors of safety, have been worked out by experience, and not by experiment or calculation. The first boilers were of iron made up in "any old way." When they failed, the part that failed was made stronger in the next boiler. When they did not fail the pressure was increased until they did fail, or if more pressure was not needed, then the next boiler was made lighter and cheaper, until finally by means of trial and error the present proportions of boilers have been worked out. The process is still going on, so that undoubtedly boilers will be either cheaper or stronger, or both, twenty years from now. As the proportions of boilers have been worked from experience and by the process of trial and error, it should be clear that the ultimate strength of the material may have nothing to do with the safe working strain, since the ultimate strength may vary without varying the safe working strain. The instances that were quoted above show only that the different modes of determining the ultimate strength may give a different factor of safety for each method, but it is also true that the actual ultimate strength may vary without changing the safe and proper working load. For instance, steel is stronger than iron, and when bridges were first made of steel, it was attempted to use the same factor of safety that had been used with iron, thus making a saving in weight and cost. It was soon found, however, that in spite of the greater strength of steel, its elasticity and the consequent deflection of the bridge under load was the same as for iron, so that to make a proper bridge no saving in weight could be made by use of steel, but instead, the same working stress and a greater factor of safety had to be used.

Further it must be noted that even when we use the working stress, as in figuring the working pressure of boilers or other apparatus, this working stress must be calculated according to the same method in each case, and that the moment there is any change in the conditions we must go right back to experience to tell us the safe proportions for the thickness of metal to be used. For instance, it is customary to take the safe shearing stress on a rivet as about 8,000 pounds per square inch. If, however, we study carefully the ordinary quadruple riveted butt-strap joint and figure not only the average stress of the eleven rivets, but the stress in each particular rivet, we find the single rivet in the outer row must be frequently stressed to something like 20,000 pounds per square inch. We know however that this rivet does not break off, so we conclude that 20,000 pounds per square inch is a safe working stress for this row of rivets, while the safe working stress for the inner rows may be less than 8,000.

These observations indicate how much our real knowledge of boilers depends on the experience of the past with the boilers that have not worked safely, and how little on theoretical considerations.

It is surprising every now and then to find how little we know of the stresses that actually occur. As Stromeyer once pointed out, nothing would seem more obvious and certain than for us to say, when we find a test piece with an area of one square inch standing a load of 60,000 pounds, that the stress is 60,000 pounds per square inch; and yet if we examine the broken part, we will always find that the two broken ends do not fit exactly together; there is a cup in the center that does not match, showing that the center undoubtedly broke first, and must have broken at a stress of something less than the average, while the outside evidently stood more. This is the case even in turned specimens, as well as in rolled specimens where the so-called "skin effect" comes in.

It would appear from this that theoretical calculations were of but slight use—and in fact, as will be shown below, there are undoubtedly cases where theoretical calculations have been of actual hindrance; but on the other hand it must be remembered that theoretical calculations are a means of expressing in a few words or symbols the results of much experience. To say that a working stress of 12,000 pounds per square inch, or a factor of safety of 5, is safe in boiler shells made of steel of 60,000-pounds tensile strength, is a short way of saying that 36-inch shells made of ¼-inch stock, 72-inch shells of ½-inch stock, and 12-foot shells of 1-inch stock, and all the intermediate sizes in the same proportion, appear to be all equally safe. To write all the sizes and thicknesses would take several pages. To give the rule takes but a few lines; but we must remember that the rule depends solely on experience, and has no particular virtue in itself beyond the experience on which it is based.

Theoretical calculations are also of the greatest importance whenever we would make any change in design or proportions. For instance, we may have two boilers, one of ¼-inch stock carrying safely 50 pounds, and one of ½-inch stock carrying 100 pounds. Theoretical considerations then indicate that if a similar boiler were made of ⅜-inch stock it would carry 75 pounds, and if of 1-inch stock, 200 pounds. In other cases theoretical considerations might show us that the change in safe pressure was proportional to the square or cube of the thickness of the material, and the designer who goes most carefully into all these theoretical considerations is the one who will most quickly improve and cheapen the design. For instance, in the case of thin cylinders such as boilers, increasing the thickness of the shell increases the strength in proportion, but with thick cylinders such as gun barrels, thickening the barrels, after a certain thickness is reached, adds practically nothing to the strength. The theoretical men who worked this out and took advantage of it in their designs saved much valuable time and material, compared with the so-called practical men who found it out only after costly experiment and failure.

In spite of the value of theoretical figuring, it has seemed to me that in boiler design in the past few years there have been cases where too much stress has been laid on theoretical considerations, and other cases where the proper lessons have not been learned from experience, and that a study of boiler explosions would show possibility of improvement. My study has not been so fruitful as I at one time hoped, but a few points which may be of value have been brought out.

The best records of boiler explosions are to be found in the reports of the British Board of Trade, of the German and French Governments, and in the technical press. The reports are made up in several different ways, are often incomplete, and sometimes obviously inaccurate, so that it is hard to draw any statistical conclusions from them; but there are found various groups of explosions due evidently to the same kind of weakness or defect which often teach a valuable lesson.

Cylinder Boilers.—We will begin with a group of a type of boiler now discarded, viz., the old cylindrical boiler 30 to 60 feet long, and some 3 feet in diameter. This boiler frequently exploded at the girth seams over the fire. On considering what happens when this boiler is under steam the cause is obvious. When first heated the lower part expands and the boiler bows down in the middle, resting its weight solely on the middle support and putting a bending strain on the girth joints. If the supports sink, as they often would, then when the boiler cools down a similar bending strain is thrown on the girth joints, but in a reverse direction. These strains apparently caused the troubles. Most of these explosions, however, appear to have started at the bottom over the fire and not at the top, which is interesting as showing that a seam is weaker in the fire than out of the fire.

The longitudinal seams of these boilers also gave way in some cases, most of the cases being seams over the fire which had leaked and been caulked or patched. This type of boiler has been discarded but its explosions have shown two important lessons; first, to take care of expansion; second, to avoid seams in the fire.

Water Tubes.—We will now turn to the most modern form of boiler, viz., water-tube. As is well-known, the explosions of this type of boiler are far more frequent in proportion to the number in use than in any other well built type, but on going over the list, it appears that the explosion consists almost always in the blowing out of a tube in the lower row, seldom doing much property damage though frequently one or more lives are lost. These tube blow outs appear in many cases to be due to defective welds, in others to thinning of the tube due to corrosion, or to overheating, caused by scale or oil.

The lessons to be drawn are; first, of course, to get better material or weldless tubes; second, to be careful and thorough about cleaning from scale; and third, to take efficient measures to avoid the presence of oil in the tubes.

The Mutual Boiler Insurance Company's investigation and study of thick boiler plates a few years back also indicates a possible improvement. Suppose instead of using the 10-gauge tubes now used, a much thicker, say 4-gauge, tube were used in the lower rows. As has been shown in the investigation on thick boiler plates above referred to, thickening the tube by this ⅛ inch would increase the working temperature of even the outside by but a few degrees. It would, in fact, decrease the temperature of the inside by a very small amount. This thicker tube, therefore, should give no more trouble from overheating than the present thin tubes, while it should last much longer under corrosion, have a much better weld, and when overheated or strained in any way, should be much stronger than the thin tube.

The study of these explosions also indicates that the tubes in the upper rows may be unnecessarily thick. The fact that it is only the tubes in the lower rows that give much trouble shows that those in the upper rows are certainly strong enough, and probably too strong. By "too strong" is not meant that any part of a boiler can be really too strong, but since the total cost of a boiler is limited, the extra money spent on making the upper tubes stronger than need be means that the money thus wasted could have been used to make the lower tubes still stronger.

It is now the custom of the water-tube boiler companies to use, I think, 12-gauge for pressures under 125 pounds, 10-gauge for pressures from 150 to 250 pounds, and 9-gauge for pressures from 250 to 350 pounds. Supposing, instead, that for pressures under 250 pounds they used 12-gauge in the upper rows and 6-gauge in the lower rows. Their boilers would be both cheaper and safer.

Internally Fired Boilers.—Another group of explosions is formed by the cases where the furnaces of internally fired boilers, such as the Lancashire, Cornish, and marine boilers, have collapsed. These explosions seem very seldom to be due to weakness, but always to overheating, whether caused by actual low water or by scale or oil. One marked difference is apparent of late years in that the more modern furnaces—whether because they are built of better metal, or on account of the superiority of the design in the use of Adamson rings or the various corrugated types, such as Fox, Purves, Morrison, etc.—are less apt to split or break or tear at the seams, but often bag down without causing loss of life or of other property than the furnace itself. Likewise short furnaces, such as in marine boilers, appear less liable to disastrous explosions than the long furnaces such as are found in the Lancashire type.

The indications for better practice are clearly in the nature of care in the operation against overheating, and the use of the modern designs of Adamson rings or corrugations.

Lap Seams.—Another group of explosions appears to be due to cracks or grooves under the lap of the horizontal seam in lap-seam boilers. These cracks as often as not do not pass through the rivet holes, but appear in the solid plate. This would indicate that the design of the seam puts undue bending stresses on the plate near the seam. This weakness is particularly dangerous, since it cannot be found by inspection in the many cases where the crack is covered by the lap. The fact that no boiler built with a butt joint and double covering strip has ever exploded by reason of any weakness at the joint shows that the way to avoid explosions from this cause is to avoid the use of lap joints in the horizontal seams.

Elephant Boilers.—Another group of explosions is found among the class of boilers known as the French or elephant boiler, consisting of two or three small drums 18 inches or so in diameter, connected by necks to a larger drum above. The small drums often fracture, occasionally in the seam but more frequently in the solid plate, the plate usually showing signs of overheating or corrosion or both. Such overheating cannot of course be caused by low water, since the upper drum, which is also exposed to the fire, would in case of low water give out long before the lower ones. The overheating is obviously due to poor circulation, since the moment circulation is checked for any reason so that steam issues from both necks of the lower drum, a steam pocket would be formed in the lower drum and the plate would be overheated. The indication for improvement is of course to change the design so as to insure good circulation, and to increase the thickness of the plates of the lower drum so that they will stand longer under such overheating and corrosion as cannot be prevented.

Lancashire Boilers.—Another group of explosions occurring in boilers of the French type, and also in the Lancashire and Cornish boilers, is evidently due to corrosion where the drums or shell come in contact with the brickwork. Some brickwork, as is well-known, is acid and will corrode under almost any circumstances, while any brickwork will take up moisture when the boiler is cold, and cause corrosion.

The indication for improvement is of course to change the design so that the shell does not come against the brick. One way of doing this would be to take a piece of tank steel, or even cast iron, and rivet it onto the shell at the point where it was to come into contact with the brick. Such a piece riveted on would take up the corrosion without weakening the boiler. In American practice there are cases, such as the brickwork on top of a horizontal tubular boiler, or the brickwork around the furnace door, where a similar corrosion would seem to be possible. The fact that corrosion does not seem to occur in these circumstances shows that for these cases no change in design need be made.

Cast-Iron Headers.—Another group of explosions is that due to the cracking of cast-iron headers of some forms of water-tube boilers and sectional boilers. Modern good practic is opposed to the use of cast iron under tension. This objection is not due to any lack of strength in the metal, since lack of strength can always be made up for by increased thickness. The trouble with cast iron is its lack of ductility. A boiler plate or stay bolt or rivet is by reason of temperature or other changes often exposed to a stress much in excess of the elastic limit, but gives slightly and permits the load to distribute itself. A brittle material, however, such as cast iron, breaks before it will give enough to distribute the load. Cast iron therefore should not be used except in such portions of the boiler as are expected to be absolutely rigid under all conditions.

Hand-hole Covers.—Another group of explosions is due to the breaking of some portion of the device used to close up hand holes or man holes. In some designs the plate is placed inside the boiler so that the boiler pressure keeps it tight, and except for leaks there is no trouble. This however involves ellipitical holes, or some equivalent device so as to get the cover inside the boiler. If circular holes are used with the cover outside the boiler, then a breakage of the holding device, or corrosion of the bolt, will permit the cover to be blown off. Several accidents have happened from this cause, the worst cases being where the attendant was engaged in tightening the bolt and the extra strain due to the tightening caused the break and the attendant was killed or badly injured as a result. While the form with outside cover is in some ways more convenient, yet the greater safety of the inside cover would indicate the latter form as preferable. The use of an outside cover with a cast-iron holding device is particularly dangerous.

Reverse Flanges.—Another group of what would have been explosions if our inspectors had not discovered the cracks in time is found among the vertical tubular boilers provided with a so-called expansion joint or reverse flange. Theory shows that these flanges are weak under steam pressure, particularly so in the designs first made, in which the flange was thin and had a large flat surface. Of course to fulfil its purpose of an expansion joint it should be thin and wide, but as a matter of experience, vertical boilers without the flange, but with long tubes, show no more leakage at tube ends than the boilers with the expansion joint. The lesson thus indicated by these cracks is either to avoid the use of the reverse flange entirely, or, if the flange is used, to make it thick and to give it a good radius of curvature.

Small Vertical Boilers.—Another very interesting group of explosions is found among the small vertical boilers used in England. These differ from those used in America in that instead of numerous small tubes of 2 inches or 3 inches diameter, one large tube or flue of some 12 inches to 24 inches diameter is used. Frequently water tubes called "cross tubes" are inserted horizontally across the single large flue.

Many of these boilers have exploded by collapse of the furnace, and at first sight this would appear to be a sign of weakness; but examination of the reports shows that the explosions are not due to weakness of design or construction but to abuse. These boilers are used for farm and miscellaneous purposes, are sold and resold second-hand without proper examination, left to rust in yards for months or years, and run by ignorant workmen. Larger boilers of the same type would receive much better care, while small boilers of other types are seldom used. The reports of the explosions show for instance "the plate was corroded to 1-32 inch thick." "The plate was corroded to the thickness of writing paper;" "the plate in adjoining portions which had not collapsed was so thin that a slight blow of the hammer would go through it." Explosions under such circumstances are not a sign of weakness of design, but they are a most powerful argument for frequent and thorough inspections.

The furnaces of these English boilers do not appear to be stiffened by stays as is the custom in most American boilers of the corresponding type. It is possible to make out a good argument showing that stays will weaken a boiler of this type unless sufficient stays are put in to make the flue as strong as, or stronger than, a flat plate of the same thickness. This theory, however, neglects the fact that stays and plates will give a little and divide up the load before they will break, and the fact that many small boilers whose stays alone or flues alone are much too weak for good practice, are running in America without giving any trouble, shows that the stays and flues do help each other. The absence of trouble is not due always to careful management, since I believe it has been said that part of the outfit of some hoisting engineers (and such boilers are almost always used on hoisting outfits) consists of a lump of iron to hang onto the safety valve when the regular pressure will not start the load.

These remarks on staying have taken us a little off the track of the explosions we were considering. The means for preventing the explosions of this class are obviously careful inspections. The use of thicker plates in the firebox will also diminish trouble and permit less frequent inspections than when thinner plates are used.

Thicker Tubes and Plates.—In the case of the tubes of water-tube boilers, the furnaces of internally fired boilers, and in one or two other cases, the opinion has been expressed above that thicker tubes or thicker plates would diminish the number of explosions. As this view is opposed to some former views and rules which forbid plates of more than a stated thickness the point should be clearly understood.

In the first case, the experiments on which the so-called factors of safety of water tubes and furnace plates are based have all been made cold at much higher pressures than occur in practice, while the records of explosions show that the troubles occur at pressures only slightly if at all above normal working pressure, but under conditions of overheating or corrosion or both. Greater protection against injury from corrosion is obviously obtained by making the tube or plate thicker and about this no argument is necessary; but there has been a feeling that thickening the tube or plate would increase rather than diminish the danger from overheating.

Let us however think of the thick tube as made up of two thin tubes of ordinary thickness perfectly welded together all over the surface, and compare this with a single thin tube. It is obvious that the inner tube of the pair that make up the thick tube can be no hotter than the single thin tube, and must be at least as strong. The outer tube of the pair will of course be hotter than either the inner one or the single thin tube, but so long as it is cool enough to retain any strength the pair of tubes that make up the thick tube will be stronger than the single thin tube.

The shells of externally fired boilers are made up to 9/16 inch thick and the furnaces of marine boilers to 5/8 inch or more without showing sign of deterioration of the outside, hence the tubes of water-tube boilers could be made up to that thickness if desired and each increase of thickness would add to the strength.

The prejudice against thick plates probably arose from the following reason. When wrought iron was in use, the thicker plates were not equivalent to thin plates perfectly welded together, but the slag in the wrought iron made non-conducting layers or laminations. A homogeneous 3/8-inch plate, as we have seen, is always stronger than a 1/4-inch plate, and practically 50 per cent. stronger. If however there should be a nonconducting layer 1/16 inch in from the water side, this would form a blister and permit the 5/16-inch outside portion to get overheated and weakened, and the plate would fail where a 1/4-inch homogeneous plate would have stood. On the other hand, however, if the blister had formed 1/16 inch in from the fire side, it would have left 5/16 inch of good metal which would have stood even better than the 1/4-inch plate, since protected from the fire by the blister. It is very possible that many plates have actually been unnecessarily weakened by cutting out such blisters that were close to the fire side, leaving plenty of good metal, in order to patch. In the case of good homogeneous steel such as we are now getting, the trouble from blisters and laminations has almost entirely disappeared, and whenever we desire to increase the strength of a plate we can do so by increasing the thickness though we cannot count on the strength increasing in full proportion to the increase in the thickness.

For cases of very thick plates and for cases where seams are in the fire other considerations might come in. There might also be cases where the greater flexibility of thinner plates was important.

Manholes and Domes not Re-enforced.—Another group of explosions of some interest includes the case where the initial fractures are found radiating from manholes or steam drums. Modern methods require of course the re-enforcement of such openings, but it is interesting to note how this requirement has been worked out by experience and not by theory. A boiler plate with 40 per cent. cut out for rivet holes is credited with 60 per cent. of its original strength, while if only 10 per cent. is cut away for a manhole opening it is considered dangerously weak because it has been found so by experience.

Groups of Explosions that have not Occurred.—While the study of actual explosions leads to many points of interest, yet it must be remembered that until the time comes when price is literally no object it will always be possible to make a boiler too strong in some part. It is not that the excess of strength is itself objectionable, but that by lightening that portion the metal or expense thus saved could be used to strengthen the weaker portion. If therefore some portion of a boiler type has never given any trouble the probability is that it is unnecessarily strong. Following out this line of thought we may consider some groups of explosions that have not occurred.

Butt Joints.—One of these of much interest is the question of butt joints with double covering strips. Such joints have I believe never given any trouble; certainly no cases of explosions are found due to weakness of such joints. It therefore follows that they are amply strong, and that there is no need to make them stronger. Hence the triple-riveted type, being strong enough, is preferable to the more expensive quadruple joint. The pitch of rivets for greatest theoretical breaking strength is greater than the pitch that gives the best caulking pitch, but this greater theoretical strength by using a large pitch may properly be sacrificed as unnecessary in order to get a tighter joint by using a closer pitch. This is a case where theory has probably done actual harm to boiler design. A formula that made the pressure depend solely on the efficiency of the joint would permit a greater pressure on the wide pitch and would encourage the boiler maker to use the wider pitch, although the boiler would actually be of poorer design than if it had a closer pitch.

Staybolting Circular Flues.—Another group of explosions that have very rarely occurred is that due to trouble with the staybolting of vertical boilers of the Corliss or Manning type with circular fireboxes. The stay-bolting of these circular boilers has usually been figured on the same basis as flat plates, but this is not necessarily correct. First of all we have the strength of the flue as unsupported by any stay bolts. The stresses due to external steam pressure on such a flue correspond closely to the stresses on a strut or column, or, to take a more familiar case, to the stresses on the wood of a bow used for shooting arrows. So long as the column or bow is perfectly straight the stress due to the load or bowstring is compression simply (assuming in the case of the bow that the string could be made to pull in line with the axis). If the column or bow is not perfectly straight, then even a slight pressure will cause it to bend slightly, though it will not collapse. As soon, however, as the load reaches some limit—depending on the elastic strength of the material—the column buckles and collapses. The load on the column, or steam pressure on the flue, at which this happens depends largely on just how closely the pressure is in line with the axis of the column, or in the case of a flue on how perfectly the shape approaches the circular form. It depends also, of course, on the thickness of metal and on the length of the column or the diameter of the flue.

If the flue is supported by stay bolts, as in the type of boiler referred to, then we have the following state of affairs. The outside shell of the boiler expands slightly under the pressure due to the elasticity of the metal. The inside flue compresses under the pressure, these movements tending to elongate the stay bolts. The stress on the stay bolts therefore tends to throw the flue into a polygonal form, and we must consider it in two lights—first, as regards the portion between stay bolts, and second, as regards strength against collapse as a whole. Unless the stress on the stay bolts be sufficient to make the portions of the plate between stay bolts absolutely flat, they will remain in the condition of a dished head or arch under compression, and will be consequently stronger than a flat plate. If the stress be sufficient to make them absolutely flat, they will then be as strong as a flat plate.

When we come to consider the question of the collapse of the flue as a whole, which is now polygonal instead of circular, it is obvious that so long as the individual arcs between stay bolts do not collapse the polygonal flue will be as strong as the circular flue, if the polygon is symmetrical.

Even if the polygon is not symmetrical it is still as strong as before, provided that it is as symmetrical as before, and must be stronger than an un-stay-bolted flue, since before it can collapse the stay bolts must break or pull out. If, however, the stress on the stay bolts should be such as to make the flue less symmetrical than before (as might easily happen if the outside shell were other than circular, or in the case of an horizontal flue with a fire inside), then the stress on the stay bolts might weaken the flue.

The general result of these stresses may now be summed up as follows:—

Stay-bolting a circular flue or furnace to the surrounding circular shell will add to its strength against collapse as a whole.

Stay-bolting a flue to a circular shell will make the individual portions of the flue between stay bolts more liable to collapse than if not stay-bolted, but they will still be stronger than a flat plate.

Now in very large boilers—say 6 feet diameter—the arc between stay bolts is nearly flat even without the stay-bolt stress; hence when the stress on the stay bolts makes it still flatter, it approaches closely to the flat plate and the pitch of the stays should correspond to that required for a flat plate, though it need not be quite so close a pitch. Just how closely this pitch should approach the pitch of stay bolts required for a flat plate can be learned best by experience.

On small boilers such as those with flues about 36 inches in diameter, where the arc between stay bolts has a considerable curve, the pitch between stay bolts need not be as small as required for a flat plate. The size of the stay bolts must also be considered as well as the pitch.

In both cases, both large and small flues, the stress on the stay bolts cannot be exerted until the flue itself is compressed by the steam pressure, on account of its circular form; hence the stress on the stay bolts will not be as great as with a flat plate, and in neither case need the size of the stay bolts be as great as is needed with flat plates.

It is possible of course to figure out a very excessive stress on stay bolts if we omit the essential consideration that a stay bolt can give slightly under stress and still exert its full strength. For instance, supposing that the stay bolts and inner flue were of brittle inelastic material while the outer shell was elastic. Then the stay bolts would take the whole stress due to the steam pressure, and the stay bolts would take the stress corresponding to the pitch of the stay bolts on the outer shell. According to the same theory if one stay bolt should be a shade, say $^1/_{1000}$ inch shorter than the others, it would take the full load and be stressed beyond its breaking limit while the others would not be strained at all. What actually happens, of course, is that the stay bolt is strained beyond its elastic limit and gives a little and then the other stay bolts take up their share of the load, and in the case of the circular flue with stay bolts there is enough play and give to the metal to divide the load.

Just how much advantage can be taken of these facts is a question that can best be determined by experience, but the fact that we so seldom find any trouble of any kind in the stay-bolting of these circular flues indicates that we can safely lighten up the stay-bolting to some extent.

The foregoing notes are disconnected and incomplete, yet it is hoped that they may bring out a few points of interest and importance. The most important part of all is that while theoretical calculations are of value, yet they must be checked up all the time by the results of experience. A bicycle manufacturer can work out his proportions by noting how many times his bicycles break down. A boiler maker cannot use the process of trial and error to the same extent, but should take advantage of all the records of boilers that have failed and boilers that have not failed to find out where any improvement can be made. The most important thing is not to design a boiler with a given factor of safety (I think it was Holley that used to call it a factor of ignorance) but to find out the factors of safety which may be 2 and may be 50, or rather the working stresses in the different parts that will give the best possible boiler for the money.

WHAT MANCHESTER IS DOING FOR ENGINEERING APPRENTICES.

By F. Brocklehurst.

The thorough examination of the apprenticeship question, contained in the series of articles of which this is the fifth to appear in this Magazine, includes the study of the subject from the standpoint of the shop superintendent, the independent trained mechanic, and the technical educator.

The first-named aspect appeared in the accounts of the Westinghouse, Brown & Sharpe, and Allis-Chalmers systems in our issues for December, 1903, and January and April, 1904. A very valuable exposition of the methods of the Baldwin Locomotive Works, inspired and directed by Mr. Vauclain, will follow in June, having been completed just too late for publication in this number.

The interesting suggestions of Mr. E. P. Watson, in this Magazine for February last, expressed the views of the independent expert shopman and mechanical engineer. The article now presented shows the British conception of the possible functions of the technical trade school in co-operation with the employer. The American idea of the same question will be summed up in a contribution from Mr. Frank T. Carlton, on "The Industrial Value of Manual Training," in a following number of the Magazine.—The Editors.

IT is not my intention to attempt to describe all that is being done in the city of Manchester for the advancement of commercial and technical education. I shall merely try to show what the city authorities are doing, singly and in conjunction with the Victoria University of Manchester, to raise the status and to improve the education of electrical and mechanical engineers. It will not be necessary to remind the readers of this Magazine of the fact that a little over a year ago a great school of technology which stands unrivalled in Great Britain was opened in the city. The object of the school has been well expressed as being to accommodate the mechanical, electrical, and sanitary engineering industries; the chemical and textile industries; architecture and the building trades; and printing and other trades and industries. It is a serious attempt to place at the service of English industry an institution which shall be adequate to its needs and importance and comparable in respect of equipment with the great institutions of the Continent and the United States.

The Manchester School of Technology grew out of the old Technical School, which in turn was the product of a one-time Mechanics Institution. These changes of name are all significant. The alteration from the title "Technical School" to "School of Technology" was accompanied by a raised standard of examination for day students, and by the determination of certain courses of study which in the absence of degree-giving power will be rewarded by diplomas. On the recommendation of the board of studies of the institution it was decided that the matriculation or preliminary examinations of recognised British Universities, and the higher certificates of the Oxford or Cambridge Schools Examination Board, or the Oxford or Cambridge Senior Locals Honours, should be accepted in lieu of the entrance examination thus determined upon. This increased standard of examination was fixed in the full knowledge and expectancy that at the outset it would have the effect of reducing the number of day students, but it was believed that what the school would lose in numbers it would gain in the quality of its future students. Concurrently with these changes the staff of the school was strengthened, and the title of professor was conferred upon the heads of its several departments. At the present time Professor J. T. Nicolson, D. Sc., late professor of mechanical engineering at McGill College, Montreal, is in charge of mechanical engineering and receives the able assistance of Mr. H. G. Jordan, the professor of mechanics and engineering drawing, as well as of a number of other lecturers and instructors. Professor Schwartz, A. K. C., is at the head of the electrical-engineering department and also occupies the post of professor of physics and electrical engineering. His coadjutor in this post is Mr. W. W. Haldane Gee, B. Sc., Lond., who is professor of pure and applied physics.

The equipment of the school is of too elaborate a character to lend itself to detailed description in these pages, but with respect to the special subjects under consideration it has been well said that the object aimed at in the mechanical-engineering section is fourfold:

1.—The teaching of engineering science as much as possible by experiment.

2.—The determination of the technological properties of the materials of engineering.

3.—The instruction of young engineers in the usual and best modes of testing prime movers, the machinery of transmission and the machinery for the absorption of energy.

4.—The provision of facilities for experimental work under the direction of the engineering staff on the present-day problems of engineering design.

The electrical-engineering and physics department contains two lecture rooms fitted with electrical experimental projection lanterns; four laboratories for work in physics and electro-technics; two dynamo and motor-testing rooms; a standardising laboratory; a high-tension room; electro-chemical engineering, photometric, and optical laboratories, together with instrument-testing, cable-testing, and accumulator rooms.

The authorities in charge of this institution are fully cognisant of the fact that its ultimate usefulness and success rest entirely upon the complete organisation of a sound system of secondary education, without which no adequate scientific technical and artistic training especially for the leaders of our industries is possible. With these considerations in their minds they have recently determined upon the transformation of a higher grade school and school of science into a modern secondary school. These buildings are in close proximity to the School of Technology and it is confidently expected that the newly organised secondary school will form a valuable feeder to its larger neighbour. It is hoped that by a suitable arrangement of fees and the creation of a number of bursaries, the professional and business men of the city who desire to give their children a good education, extending until at least 16 or 17 years of age, will take advantage of the new means thus afforded as a preliminary to a technological course in the School of Technology. The courses of instruction in the new school are designed to extend the pupils' knowledge of their mother tongue so as to secure greater facility and accuracy in its use and a wider acquaintance with its literature. It is also intended to devote greater attention than has hitherto been the case to the important subjects of geography and history, to give an effective training in foreign languages not excluding Latin, to give a sound training in the elements of mathematics and in the general principles of science, and, in addition, to give systematic instruction in the use of tools and in drawing. There are at the present time 1,386 boys and girls in attendance at the Central Municipal school, of which number 478 are in the second division. The ages of the latter range from 12 to 16. Of the 478 already mentioned 390 are boys.

In the School of Technology itself there are at the present time no fewer than 2,016 enrolments in the electrical-engineering department, but the actual number of pupils is somewhat less, as some of the pupils are enrolled in more than one class. In mechanical engineering there are 1,620 enrolments. The day students are of course very considerably less in numbers. There are 83 students following the first year's course, which is of a general character. The subjects of this course are mathematics, English, German, geometrical and engineering drawing, mechanics, physics, and chemistry, including laboratory work in each of these three sections, and wood-working exercises. At the end of the first year the student specialises according to the profession which he hopes to follow. In the second year's course for mechanical engineering there are 27 students, while 37 are taking classes in electrical engineering. It must be admitted that these numbers are far from satisfactory, but they are not discouraging in view of the fact, previously recorded, that the authorities of the school have raised the whole standard of their education and examination, and have thus made the doorway of entrance considerably straiter. They are at the present time taking important steps with the object of making the benefits of the school more widely known, hoping thereby to attract a considerably augmented number of pupils. Partly with this object in view they recently called upon a large number of employers in the districts in which the subsidiary institutions are situated, with the object of persuading them to give facilities to their apprentices to attend evening classes therein. The result has been most satisfactory. The numbers attending have been augmented and in many cases the employers have paid their apprentices' fees.

The growth in the number of day students does not proceed at the same rapid rate. A valuable experiment was made by a local firm, which unfortunately has not been followed. The firm in question sought to combine the theoretical training of the school with the practical experience of their own workshop, and with these objects before them they selected the most promising of their apprentices and paid his fees at the School of Technology, and, in addition thereto, paid him the wages he would have earned had he remained at work. The arrangement they made with the school and their apprentice was that as often as the school was open he should attend classes, but that during vacations he should return to the workshop. He was in fact to be a regular day student throughout the session. A scheme having for its object the relief of deserving apprentices from the arduous conditions of evening study has lately been put forward by Mr. J. H. Reynolds, M. Sc., the principal of the institution. Circulars were issued to engineering employers far and near inviting them to send certain selected apprentices on one day in each week to the school. This circular was well received. A conference was held with the Manchester Association of Engineers last October, and the final outcome was a scheme of which the following are the chief features: the apprentices selected by the employers are not to be below the age of eighteen years; they must be possessed of a knowledge of the elements of mathematics and drawing, and be of such good character in respect of conduct and capacity as to deserve the privilege offered. The course of study commences each Monday at 9.15 and continues to 1.15. A break of three-quarters of an hour is allowed for lunch, and studies are then resumed from 2 to 6. These comprise mathematics, lectures on engineering, laboratory exercises, and the teaching of mechanical drawing. The instruction imparted is made as advanced in character as the educational condition of the student permits, and the fee for the complete course is fixed at 30 shillings. These apprentices are not expected to attend evening classes. Each Monday afternoon sufficient home work is given them to last for the remainder of the week, and on the succeeding Monday this work is reviewed by Professor Jordan, who is in charge of this department, and marks are given in accordance with the result. Monthly reports of his attendance and progress are furnished to the employer sending the apprentice. Absentees are also to be reported at once, but up to the present time such cases have not arisen. The reason for this, apart from the attractiveness of the course itself, is that a selected apprentice who is absent from these Monday day courses loses his day's pay.

At the present time seventeen firms have amongst them sent forty students, and Mr. Reynolds says that this number is as many as can conveniently be accepted without a further increase of staff. As previously indicated, the wages of these apprentices are paid by the firms sending them, and in some cases their fees are also met from the same source. The great merit of the arrangement is that it relieves students who are otherwise working all day from the severe work of evening studies. Some of the applicants for permission to attend these Monday day classes in engineering had to be refused because they were not sufficiently advanced to take proper advantage of the studies. The present course ends with the close of the school academical year in July. If the employers are willing to allow these apprentices to attend a second year, the authorities of the school will select the best of them for a further year of training in more advanced subjects. An examination will be held at the end of the session by their respective teachers which will show the relative positions of the student, and those who have not shown aptitude for their work will be weeded out. These Monday classes are primarily intended for apprentices who it is hoped will in due time become foremen of departments. The scheme is at present confined to engineering apprentices; still, there is nothing to prevent a similar course of study being taken up by apprentices in other industries. The example is certainly well worth following.

Whilst the authorities of the Manchester School of Technology have, in the manner already indicated, taken steps to improve the education of working apprentices, they have by no means been neglectful of those who are destined to become heads of department, managers, and employers. As Mr. Reynolds said to me the other day, the crux of the whole matter is the education of the employers. As he expressed it:—"We all want, it is true, to do whatever we can for the rank and file, but if you can get the employers educated they in turn will look for better trained men about them than those they have at present." If the bulk of the employers were really technically trained men they would undoubtedly ask for similar intelligence in their employees. It must be confessed that at the present time they look down upon the technically trained student. They allege that if they ask him to do anything he finds that he has forgotten his formula. This is of course a mere libel, and it presupposes a misconception as to the real objects of schools of technology. These schools are not designed to turn out engineers. They were never meant to do this work. All that they were ever intended to do was to turn out men who should make good engineers. I have already suggested that with the object of attracting students who are likely to be in positions of responsibility, the School of Technology established three-years courses for day-students in mechanical engineering, electrical engineering, technical physics, and other technical subjects, and as at present arranged the diploma of the school will be awarded to those students who satisfactorily fulfil the conditions of this course. The Manchester Corporation had scarcely determined upon the creation of this three-years course with its consequent diploma when an agitation emanated from Liverpool, having as its object the dissolution of the Victoria University into its three component elements. Following upon the applications made to the Privy Council, new charters have been conferred upon the Colleges of Manchester and Liverpool and an application is now before Parliament to do the like for Leeds.

This was a splendid opportunity for the Manchester people and full advantage was taken of it. In response to their representations, the charter of the Victoria University of Manchester contained a provision for the institution of a faculty of technology, and by an agreement which has been entered into between the Corporation on the one hand and the university authorities on the other, certain day-courses of the Technical School are to qualify for degrees in the Victoria

University of Manchester. It should perhaps be explained that the new universities are not like the old Oxford and Cambridge Universities of which the constituent elements are colleges, but on the contary are constituted of faculties, such for example as the faculty of arts, medicine, law, etc. Two of the latest faculties to be created in Manchester are those of commerce and technology. The faculty of technology has not yet been fully established. It is still the subject of negotiation between the Corporation and representatives of the university, but certain of its broad outlines have been agreed upon. Certain subjects taught in the day-courses of the school of technology are to be within the purview of the faculty. These have not yet been definitely decided upon, but it is almost certain that amongst them will be found mathematics as applied to technical subjects, mechanical engineering, applied chemistry, and applied physics. The members of the board of faculty are to be such of the present members of the board of studies of the School of Technology as are engaged in the teaching of the subjects previously referred to, together with five or six representatives of the University. The present members of the board of studies of the School of Technology in the subjects of the faculty who are not nominated professors of the university will become lecturers. There will be a matriculation examination which will be regulated by this joint matriculation board. At the completion of the three-years course degrees in technology will be conferred upon successful students. As will be readily understood the day students of the school of technology who take this degree course will be members of the Victoria University of Manchester and will be required to conform to its discipline, by-laws and regulations. For all practical purposes this happy arrangement between the Corporation of Manchester and the Victoria University constitutes the School of Technology an integral part of the university so far as its day courses in the subjects enumerated are concerned. As I have already explained, the full details of this working arrangement have not yet been decided upon, but it is the hope of those interested in the question that in some way or other honours degrees may be obtained in technology. The proposal that meets with the greatest acceptance at the moment is that at the end of a three-years course for the ordinary degree, a student in technology should be required to do an amount of independent research work covering a period of another academic year, at the end of which time he should be called upon to write a thesis, and that such post-graduate work and thesis should be the qualification required for a degree in honours.

I have already given the number of evening students in attendance on the courses in mechanical and electrical engineering in the Manchester School of Technology (the number of *individual* students enrolled in the institution exceeds 5,000) and have also indicated the character of the work done by those selected apprentices who attend the engineering classes on Monday. For these students opportunity should be afforded of crowning their educational work with a degree, and I have reason for saying that steps will be taken in the near future with that desirable end in view. It is recognised that those students who are permitted to seek this honour should be men of high intelligence and also be possessed of a broad general education of a secondary character. With qualifications of this nature there is no reason why they should be denied the privileges which are readily conferred upon those students whose means permit them to attend the regular day courses of a university. A five- or six-years course at an evening school is surely an equivalent of a three-years course during the day. No pains will be spared to secure university recognition of the evening students in technology in Manchester. If this recognition cannot be obtained locally students will seek it elsewhere, since the University of London, by the terms of its charter, can accept for its external degrees any duly prepared evening student.

Enough has been said to show that the city of Manchester is fully alive to the importance of the industrial problem which has been created for Great Britain by her Continental and American rivals. As I have already indicated, the solution of the problem has been sought along educational lines, and in this pursuit the city has not only erected a magnificent school of technology and equipped it with machinery and staff second to none in the country, but has also endeavoured to fill the gap which unfortunately lies between the primary and technological schools, to increase the number and to raise the status of the pupils at the latter institutions, and to enable the study of science as applied to industry to take equal rank as an educational instrument with those subjects of study which find special favour in the ancient British universities.

EDITORIAL COMMENT

WITH a somewhat quieter home demand for engineering manufactures than has been experienced for a few years past, the attention of American builders of machinery and tools is likely to turn again more actively to foreign markets. Since the last great occasion six or eight years ago, when the search for an outlet abroad was so general and so keen that Europe took fright at the "American Invasion," our manufacturers have kept a foothold in and a watchful eye upon that field, if not more. But as Mr. Clark so well says in his leading article in this issue, "America itself is by far the best market of the world for manufactured products; consequently it is not strange that up to the present American manufacturers should have devoted their principal attention to home trade." The foreign field was a surplus market, rather than one of first selection. And scarcely had the outposts been well established, when the home demand leaped to such figures that the more distant campaign lagged, for want of sufficient motive to push an advance.

If now, as seems possible, the overpressure of the nearer demand may slacken for a time, export trade will reassume importance in the calculations of American managers, especially as the conditions abroad (which have been far from inflated during the time of our own home activity) are looking more promising for an expansion of business. From Germany, which has long been in the depths of depression, come most encouraging reports of reviving business and busy shops. The market conditions of the last decade, at home and abroad, afford the most suggestive and instructive example possible of the compensating effect of foreign trade and the stability which may be given to a manufacturing business by the cultivation of an export market.

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ONE significant point is to be noted in the prospects of the immediate future. When conditions advance the foreign market to a position of greater relative importance to our manufacturers, we shall open the campaign of renewed activity from a vastly more advanced stand than that which formed the base of the preceding "invasion." In conception of the possibility of doing business abroad, in the knowledge of the market and the buyer, and—by no means least—in prestige and standing in the eyes of the world, the American machinery and tool manufacturer gained a long lead then, and in any further effort will start from that advanced position. And, on the other hand, our foreign competitors has been a proficient student of many of the very things which won us our early victories, and the difference in weapons, on the mechanical side, has been and is being leveled up. Our prime need is the development of a commercial system equal in excellence to our manufacturing system. Mr. Clark's article is an invaluable contribution to the most important study of the day.

During the past few years there have been various commissions, commercial, industrial, and educational, sent from different parts of Europe to investigate and report upon the methods of doing things in the United States. All such visiting parties have been welcomed and aided in their work, American engineers and men of affairs having most appreciative recollections of courtesies received in various parts of Europe upon similar occasions abroad. The present year will be especially full of affairs relating to what may be called the social side of the engineering profession, since announcements have been made of a number of visits of European engineers to America.

The first of these visits will be made during the present month by the Institution of Mechanical Engineers, a large party, including the president and the secretary, having arranged to come to the United States to hold their convention at Chicago, in conjunction with the American Society of Mechanical Engineers. This is a most welcome return of the joint convention held by the same societies in London in 1900, and there is every reason to believe that the meeting will be productive of most valuable professional and international results.

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The next visit in point of date is that of the Société des Ingénieurs Civils de France, of which society a representative body will sail in the latter part of August. While no especial professional meetings have been arranged at that time, there is no doubt that the French engineers will receive a hearty welcome, not only during their local visits, but also at the exposition at St. Louis. We have a most pleasant recollection of the visit of the members of this society in 1893, and it is especially appropriate that they should attend the celebration of an important event in the international relations between France and America.

The visit of the French engineers will be followed closely by that of the Institution of Civil Engineers, and this party, like the members of the French society will devote itself mainly to a tour of inspection and recreation. While they will be the guests of the American Society of Civil Engineers in a social manner, we understand that no joint professional sessions have been planned.

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The Iron and Steel Institute, arriving in America in the latter part of October, will hold its own convention in New York, after which an extended visit will be made by the members to various parts of the country, and doubtless many of the visitors from all the societies will spend a portion of their time at St. Louis.

In all there will be between 1,500 and 2,000 visitors from England and the Continent in this country between May and November of this year, and American engineers in all parts of the country will have the opportunity of welcoming their friends from Europe, and of reciprocating the many hospitalities which they themselves have received while abroad.

Already plans are being made for the reception of the visitors, and local committees are being formed in the different cities and districts where visits are anticipated, and there is no doubt that every facility will be afforded to the members of every branch of the profession to see what is being done in their various lines of work. American engineers have always been made welcome abroad, and now it is their turn to greet their friends and colleagues.

REVIEW OF THE ENGINEERING PRESS.

"THE WORLD IS ITS FIELD"

GRADUATE APPRENTICES.

SUGGESTIONS FOR THE IMPROVEMENT OF THE POSITION OF THE TECHNICALLY TRAINED APPRENTICE IN THE AMERICAN RAILROAD SHOP.

W. F. M. Goss—Western Railway Club.

IT is generally appreciated at the present time that the true way for a nation to benefit by its opportunities in connection with technical education is to provide for the proper connection between the school and the workshop, so that the young graduate may be given full opportunity to make his theoretical training of value, from the start, both to himself and his employer. In this respect the United States is undoubtedly in advance of Great Britain, since no money premiums are required by the employers, and in most cases a living wage is paid from the start. So much has been said from the favorable side of this question that it is wise to give all phases of the matter thoughtful attention, since it is only by the joint education of employer and employee that the greatest benefit can be secured.

For this reason the thoughtful address of Professor W. F. M. Goss, recently delivered before the Western Railway Club demands attention. The fact that Professor Goss is connected with Purdue University, and has therefore most excellent opportunities of knowing the relations between technical graduates and the leading railway companies of the United States, lends especial value to his opinions.

The general idea underlying the relation of the technically trained graduate to the ordinary apprentice is that he is far better fitted to learn than is a young man who has not had the advantages of a higher education, and that therefore he can readily acquire the practical knowledge in far shorter time than the old seven years' apprenticeship. With this greater ability to acquire practical knowledge comes also greater ambition on the part of the apprentice. He does not consider the possibility of remaining an ordinary workman, but aspires to higher positions, such as in time he should be qualified to fill, and it is this phase of the matter which is especially considered by Professor Goss.

"The technical graduate who enters upon a special apprenticeship, by so doing announces that he intends to work for an official position on the road; and the company, in accepting him, agrees so to train him that he may be worthy such a position. In view of this compact, the special apprentice accepts a low wage, and the railroad company undertakes to vary his task, notwithstanding the fact that such a course limits, for a time, the usefulness of the apprentice.

"On a very few large railroad systems the course for special apprenticeships has been worked out with care. Students in such courses are handled with intelligence and consideration, with the result that they are satisfied, while the road accomplishes its full purpose in training men for its service. Most roads, however, undertake to receive special apprentices with no adequate understanding of their responsibility in the matter. It often happens that injustice is done the special apprentice and that in the end the road fails in its efforts to make him a means of strengthening its organization."

Professor Goss compares these conditions, mainly to the disadvantage of the railroad companies, since those who use the special apprentice intelligently appear to be greatly in the minority. If the wages are insufficient to make the apprentice at least self-supporting, the best men will be turned away; and if sufficient opportunity for acquiring valuable information is not given, the whole object of the system, that of producing able men for future service, will be defeated.

"Some roads have fallen into the habit of receiving technical graduates, ranking them as special apprentices, and of then undertaking to see how valuable they can be made to the road, without much regard for the rights of the graduate. By this arrangement it is possible to secure a man for 12 or 14 cents an hour, who can run a lathe, make a drawing, summarize statistics, conduct an experimental investigation, inspect material, report on defective equipment, test a locomotive, figure the bracing for a boiler, outline a scheme for motor-driving in an existing shop, install motors, or interview a division superintendent in behalf of his chief. When a road keeps such a man busy under the hardest sort of conditions, perhaps transferring him to a roundhouse or division shop remote from the center of the road's activity, where he has no contact with men who can aid him and few opportunities to observe processes which can instruct, the attitude of the road toward him is lacking in that element of fairness which is essential to permanent success. An organization in which such things are possible is obviously not ready for a special apprenticeship. It needs more than other roads, perhaps, the technical graduate, but it has no right to accept him as a special apprentice. It ought rather to take its technical graduates as it takes other men, not for the purpose of training them, but for getting service from them, and having them, they should pay them what they earn."

Another defect in the special apprenticeship course, as now generally conducted, is the fact that, during the entire length of the course all the men are paid alike. While at first this is perfectly proper, it prevents all discrimination of merit and effort and may have the disastrous result of killing any attempts of the more ambitious men to do their best, the incentive being altogether too remote to be effective. It is only by a carefully and justly stimulated competition that the best can be brought out, and that the process of sifting out the various degrees of ability can be fully effected.

"Again, underlying the special apprenticeship course as administered upon most railroads is a conception that the technical graduate must be made to overcome as many difficulties as possible. He is set to work with a gang of men unfriendly to his purpose and to him; he is often required to work under a foreman whose chief desire for the time being is to make him show a white feather. He is given the heaviest end of the lever and is required to keep lifting long after the necessity for effort has passed. As a rule, he does not complain, and it usually happens that the men who were factors in making his lot hard are among the first to start a song in his praise. But even though the process seems to work out successfully, it may not be wise. When one's task is made hard merely for the purpose of opposing him there is something wrong. When the same form of opposition is many times repeated, when the apprentice is changed from one gang to another, from shop to roundhouse, and from roundhouse to special investigation, always in the attitude of defense, the process ceases to be disciplinary and uplifting. It tends to dwarf the man rather than to draw him out. Manufacturers, in dealing with the same matter, have learned to handle it in a much more satisfactory way, their plan being to give the technical graduate official recognition from the beginning."

In these matters it appears that the great manufacturing corporations have shown a far greater degree of business discrimination than exists among the railway companies. The various papers which have appeared in recent issues of this Magazine, and that which will appear in the next number, upon the practice of the Baldwin Locomotive Works, show very clearly the extent to which this important matter is understood by the great engineering works of the country, and it is becoming evident that if the railroad companies fail to appreciate their opportunities in this important element of their work they will be avoided by the best portion of the technically trained men who are seeking opportunities to enter practical work.

The attitude of some establishments is that of conferring a favor upon the student by admitting him to the privilege of working within their sacred limits, and this view has doubtless been the result of the eagerness of young men, in times past, to get into the works. With the development of other lines of work, offering fully as great if not greater ultimate advantages, together with an intelligent comprehension of the proper means of availing themselves of the better grade of ability offered, the railroad shop has placed itself at a disadvantage. Professor Goss has done well in bringing this matter to the attention of the administrators of railway works management, and if they do not see fit to profit by his candid advice, they will have no one to blame but themselves.

THE MANUFACTURE OF CALCIUM CARBIDE.

AN IMPROVED ELECTROLYTIC METHOD OF PRODUCING CALCIUM CARBIDE AT MODERATE TEMPERATURES.

Henri Moissan—Comptes Rendus.

IT has long been recognized that the commercial use of acetylene in the arts, both for purposes of illumination and for heating, as in the recently developed acetylene-oxygen blowpipe, must be largely dependent upon the cost of calcium carbide from which the gas is made. Since the actual amount of electrical energy required for the production of a definite amount of calcium carbide in the electric furnace can be accurately computed, the minimum cost can be determined, and this cost has heretofore been too great to permit of the extensive use of acetylene, its applications being consequently limited. In a communication recently made to the French Academy M. Moissan, whose share in the original development of the carbide and acetylene industries is well known, describes a new method for the production of calcium carbide, which, while a present only a laboratory process, may be capable of development to commercial proportions.

It has already been demonstrated by M. Moissan that in the present method of producing calcium carbide in the electric furnace, the carbon reduces the lime only when the latter has reached the liquid state. This fact necessitates the employment of extremely high temperatures, involving the use of the electric furnace, with its attendant inconveniences and expense. M. Moissan has also shown, however, that metallic calcium will combine with finely divided carbon at a dull red heat, producing pure crystalline calcium carbide. It follows that when calcium is electrolytically produced in the presence of carbon at the temperature of a low red the result will be the formation of carbide. Two methods of applying this principle are described by M. Moissan, both of these having been experimentally demonstrated by him.

The first experiment consists in the use of a graphite crucible for a container and at the same time serving as the positive pole, this being supplied with calcium chloride, into which a vertical negative electrode of carbon is inserted. After the charge has been fused by the passage of an arc the electrolysis is continued by the passage of a current of 10 to 15 amperes at 120 volts. A crust soon forms upon the fused mass, protecting it from the air, while chlorine is freely disengaged and calcium set free, fresh portions of calcium chloride being successively added. The resistance of the bath varies continually, this being probably due to the formation of a subchloride under the varying conditions of the electrolysis. In about an hour the crucible may be broken, when a crystalline mass is found, which, when projected into water, liberates a gaseous mixture of hydrogen and acetylene. Examination shows the mass to consist of calcium and calcium carbide formed from attack upon the electrodes.

The second process is a modification of the first by the addition of about 20 per cent. of calcium fluoride to the chloride. This gives a much more fluid bath which conducts the current very uniformly. Brilliant crystals of calcium form upon the carbon electrode as may be seen with a magnifying glass, and these, in contact with water, give off hydrogen mixed with acetylene. By adding to the mixture a certain quantity of petroleum coke in the form of a coarse powder, the electrolysis will proceed as before, but the proportion of carbide will be notably increased. By stirring the fused mass during the operation, in order to bring the carbon into continual contact with the bath, a mass will be produced, which, in contact with water, liberates hydrogen containing from 35 to 59 per cent. of acetylene.

If the direction of the current is reversed the deposit of fused salts containing the calcium and the carbide will be found adhering to the walls of the crucible, and in this case the hydrogen liberated by plunging the mass in water is found to contain as much as 65 per cent. of acetylene. By washing in alcohol the crystals of calcium and of calcium carbide may be separated.

These experiments go to prove that calcium carbide may, under suitable conditions, be produced during a secondary reaction, at a temperature of about 650° C., determined by the thermo-electric couple.

As M. Moissan remarks, these are but laboratory experiments, and their practical application does not immediately appear, but it must be remembered that the early experiments of Willson were originally directed to the production of metallic calcium, and that the resulting calcium carbide was a secondary matter. The electrolytic action in the production of aluminum is a case not greatly different from these recent experiments of Moissan with calcium, and there is reason to believe that a repetition of his investigations upon a large scale may lead to results of commercial importance.

PACKING OF MACHINERY FOR EXPORT.

INFORMATION FOR THE INSTRUCTION OF SHIPPERS OF MACHINERY AND MECHANICAL APPLIANCES TO THE CONTINENT.

Paul Roux—American Chamber of Commerce in Paris.

THOSE who have had the opportunity of observing the various elements which enter into success in export trade in machinery will realize the extent to which careful and intelligent packing affect trade, and for those who have not had this experience the paper of M. Paul Roux, presented before the American Chamber of Commerce in Paris will be of interest and value. M. Roux speaks with the knowledge derived from experience in handling American made machinery in France, and his familiarity with conditions in both countries lend added weight to his words. As he rightly says: the care which is given to packing and preparation for transportation and delivery may not only affect the cost of these operations but may also bear a considerable influence upon the expenses of transportation, custom dues, and storage; and these expenses, in the case of machinery exported from the United States to France, may amount to a considerable percentage of the selling price.

Assuming that a machine has been assembled and inspected in running order, it should in most cases be dismounted and packed in cases representing not more than 2 tons, whenever possible. It must be remembered that for shipping purposes 40 cubic feet are rated as one ton, and unless care is taken in the packing of parts of machines this cubic bulk will be exceeded, to the greatly increased cost of shipment.

Fragile parts should be dismounted for their own protection, even if no reduction in bulk is secured, screw threads being covered with wood or rags and tapped holes closed with wooden plugs. All parts should be most carefully tagged, their positions on the machine being so fully explained that salesmen and others who might not be fully conversant with the machine should be instructed as to their proper places and functions. Finished parts should be protected with a thoroughly efficient coating, and inspection should be made during the packing to ascertain that the coatings are intact after the handling of the packers, otherwise the machine may arrive at its destination almost useless from rust.

"The packing-case must fulfil two requirements: it must effectually protect the machine against all shocks and injury during transportation, and must facilitate the handling of the machine—that is to say, that the packing case is at the same time a covering and a vehicle.

"In order to fulfil this double requirement, the case should be specially constructed, and, without fixing general rules, as the details of construction will vary considerably with the forms of different types of machines, the essential requirements will be given for packing-cases containing a machine which is of a weight too great for moving by hand.

"The bottom is the most important part of the case, considered as a vehicle. If this is well designed, it will not only facilitate handling during transportation from the United States to France, and contribute greatly to removing risk of injury, but it is the only part of the case which can be utilised in France if, after remaining in show rooms, it is to be shipped by rail to its final destination. The bottom should therefore be sufficiently strong to carry the total weight of the machine, without the assistance of any other part of the case, when balanced on a roller. It should be constructed with two longitudinal battens, in order that the case may be moved on rollers when cranes are not available, and these battens should be bevelled at the ends to facilitate their employment. Transverse planking, spiked to the battens, forms the bottom of the case. On the bottom, constructed as indicated, two frames should be built around the machine, dividing the length of the case in three parts, in such a manner as to support the pressure of ropes or chains when handling with cranes or other hoisting apparatus. These frames will, at the same time, act as supports for the interior braces, and as lateral supports in case the package is laid on its side, which often happens in spite of instructions. Around these principal elements are built the sides, ends, and top of the case, which are designed simply for protecting the machine generally. In constructing the packing-case, the remarks already made regarding its volume, must be borne in mind. This volume is computed from the over-all dimensions, and often a bolt-head, or a batten, badly placed, will largely increase the cubage.

"In designing the packing-case, it is very necessary to make provision for the examination of the machine in the Custom House, and even for removing it completely. It it absolutely necessary in all events to arrange an opening in one of the sides or in the cover, through which the nature of the machine may readily be seen. This opening should be large enough to permit the examination of all parts of the interior of the case, and to permit the passage of a lantern, if required. It should be closed by a cover secured with screws.

"To allow for removing the machine completely from the packing-case, in order to determine the net weight of the machine for the Custom House, it should be arranged so that the packing and the unpacking may be readily and rapidly accomplished, without it being necessary to injure the panels. For this it is necessary that the top, and one of the sides, be secured with screws, instead of nails, and that the position of the interior battens and braces be indicated externally, in order that the screws and nails fixing them may be readily found."

An important point suggested by M. Roux, and one which is not always considered, is the provision of a list of all detached pieces, together with a drawing, blue print, tracing or engraving showing all accessories which are indispensable to the machine. Such parts as countershafts, keys, wrenches, change gears, etc., must be fully identified as parts of the machine or they may be classed as having to pay a higher duty than the machine itself, and since the machines may be divided into several packages, such a drawing or illustration should be placed in each packing case, since all the cases are not always opened by the customs officers.

Proper marking of the cases is most important, not only for purposes of identification, but also for the use of the customs officers. The exact net weight should be marked on every package, as even a small difference between the marked and the actual weight may cause the imposition of fines. The bulk is the product of the three dimensions over all. In addition to the ordinary marks there should be put on the exterior of each case a list of its contents, this being of especial importance if the cases are to be stored in a warehouse.

In order that a case may be opened with the least delay and without injury to its contents it is recommended that a black circle be painted around the heads of the nails or screws to be removed for unpacking.

These details may seem numerous and unnecessary to many exporters, but they may well be tested by the rule: "Put yourself in his place." The importer has to meet the customs inspectors with prompt answers to all inquiries, or at least with ample facilities for enabling them to make the required inspections. Discrepancies between marks and facts at once arouse suspicion and cause delay, while evidence of good faith and full information must expedite matters which are slow enough even in the most favorable instances. Again, care in packing will generally save far more than its cost in the reduction in breakages, and in the satisfaction which shows itself in repeated orders. If the rules and directions so carefully indicated by M. Roux be examined thoroughly they will be seen to be based on common sense, and to involve very little more trouble and cost than the present slipshod methods of packing which have done so much to discredit machines which in themselves would have been wholly acceptable.

M. Roux has done both American shippers and French importers a service by his timely and valuable paper, which should be studied in full by all who are engaged in sending machinery to any part of the world.

THE FATE OF THE CHAMP DE MARS.

PROPOSITIONS TO IMPAIR OR TO IMPROVE THE GREAT EXPOSITION GROUND OF PARIS FOR THE BENEFIT OF THE PUBLIC.

E Hénard—Le Génie Civil.

FROM time to time reports have appeared in the public prints to the effect that the Champ de Mars, in Paris, the scene of so many triumphs of art and industry in connection with the various international expositions, was to be largely given over to buildings of a permanent nature, and that the remaining vestiges of its former uses were to be entirely removed.

As a matter of fact such a proposition was entertained almost immediately after the close of the exposition of 1900, and the statement was openly made that the maintenance of such an open space was a heavy charge upon the municipality. The plan was then made to turn this historic ground into a real estate speculation, preserving only a limited portion for public gardens. It was hardly to be expected that such a proposition would be permitted to pass unchallenged, and we are glad to notice the energetic protest which has been made by M. E. Hénard, himself a member of the staff of the Universal Exposition of 1900, in the pages of *Le Génie Civil.*

As M. Hénard well remarks, the Champ de Mars has been the Forum of Paris. Originally set apart in 1752 as a parade and exercise ground in connection with the Ecole Militaire, it has been the scene of many notable events in the history of France. Here, on July 14, 1790, the first anniversary of the fall of the Bastille, was held, the Fête de la Federation. Here Napoleon distributed the eagles to the army, and here in 1830, Louis Philippe presented the colors to the National Guard. In 1848 the Fête de la Concorde was held on the Champ de Mars, and it was the scene of various spectacles during the second Empire. Four international expositions have been held upon this site, those of 1867, 1878, 1889 and 1900, each of greater importance and magnificence than its predecessor, while during the intermediate years portions of the grounds have been used for exhibitions of a special nature. During the past forty years large sums of money have been expended in providing means of access to a spot to which such great crowds have been attracted. The avenues Rapp and Bosquet have been cut through, and omnibus, tramway, boat, and railway connections have been multiplied. Stations of the surface and underground railways have been provided, and even as late as the exposition of 1900 the expense incurred i connecting the Ceinture railway with the grounds reached nearly 20 million francs.

At the present time there are on the grounds two structures which were originally erected for the exposition of 1889, and were also used in the exposition of 1900. One of these is the famous Eiffel tower, and the other still bears its original name, the "Galerie des Machines." This latter is undoubtedly one of the finest halls ever constructed, having a clear width of 375 feet and a length of 1,360 feet, there being side wings or aisles 48 feet wide, extending the entire length of the building. The height of the peak of the roof is 160 feet from the ground, and the absence of columns or obstructions of any sort makes the building available for any purpose. Including the galleries across the ends there is a floor area of nearly 19 acres available for civil or military purposes. This fine hall extends across the width of the grounds at the end nearest to the Ecole Militaire, while near the other end rises the Eiffel tower, too well known to need any description here. The area of the Champ de Mars is 44 hectares, or about 109 acres, it thus being the largest open space within the limits of the municipality of Paris, although much smaller than any of the parks in London.

That it should be decided to demolish such noteworthy and useful structures as the Galerie des Machines and the Eiffel tower, and transform this fine breathing space into built-up blocks of houses is indeed to be deplored, and it is to be hoped that even at this late date wiser counsels will prevail and the ground saved.

M. Hénard submits a plan for the utilization of the ground which is illustrated in the article under consideration, and while this may not be wholly acceptable it offers many attractive features. Recognizing the fact that automobilism and aeronautics are among the most conspicuous questions of the day it is proposed to convert the Galerie des Machines into a house for the shelter of dirigible balloons and other machines, the open ground without furnishing an admirable starting place for trial trips and other excursions. The same space is available for an automobile track, and other portions of the grounds may be laid out for football, tennis and other out-door games, while the Eiffel tower will remain to continue its services to meteorology, experimental mechanics and observation, as in the past.

Thus, although it is certain that these grounds will no longer be used for the purposes of international expositions, they may well be preserved for continual usefulness, serving also for the site of special exhibitions, and for the various occasional demands for a place of public meeting. It is certain that Paris is none too well supplied with open spaces within the the limits of the fortifications, and no efforts should be spared to preserve the Champ de Mars from the fate to which it has apparently been devoted.

MAIN-LINE ELECTRIC TRACTION.

AN ESTIMATE OF THE PROBABLE COST OF EQUIPPING THE RAILWAYS OF ENGLAND AND WALES WITH ELECTRIC POWER.

F. F. Bennett—Institution of Electrical Engineers.

It is difficult to draw accurate conclusions from data which have not been derived from the same line of work as that to which the application is to be made, and sometimes it is not easy to be sure as to the applicability of the results at hand. Thus we have an abundance of information as to the costs and returns of electric and interurban tramways, but when it is sought to apply these to the problem of main-line electric traction it is necessary to be exceedingly cautious. In a paper recently presented before the Institution of Electrical Engineers, Mr. F. F. Bennett examines the question of the electrification of the mail railway lines of England and Wales, deducing, so far as may be, what such an undertaking would cost.

Concerning the relation between the headway of traffic and the commercial success of electric traction, Mr. Bennett does not agree with the general opinion that a close headway is an absolute necessity, although it is naturally a desirable feature.

"The opinion held by the large majority of electrical engineers on railway electrification is, that for suburban traffic only is it justified. It has been suggested that the electrification of main or trunk lines might result in a loss to the undertakers, as the load-factor at the power station would be a very poor one owing to the infrequent headway of traffic; but I shall endeavour to show otherwise. On the other hand, the suburban traffic existing in thickly populated areas calls for a more frequent headway and a greater acceleration of speed. This is not only desirable, but is quickly becoming a necessity, if the suburban railway system is to hold its own with municipal tramway competition; and it can be best attained by electrical methods.

"The contention relative to main-line electrification is true if the separate railway companies only considered their own systems, and made electric power provision to meet each individual section of their own lines. If on 50 miles of railway, no matter where located, one power station were placed in the centre to work that section only, it stands to reason that the expenditure for electrification would not be justified. But, if the plant were competent to work the said section 25 miles north and the same distance south of the centre of power, it would also be competent to work all the network of lines within a radius of 25 miles, including even those belonging to other companies."

Taking the railways of England as 15,308 miles, and allowing one power station to every 50 miles, Mr. Bennett computes that there would be required 306 stations, with as many independent superintendents and managers, a state of affairs which would conduce to a reign of chaos, and be prohibitory to any free interchange of traffic. Instead, therefore, he proposes an altogether different plan.

"Assuming that the country could be divided into areas of 900 sq. miles, and a central power station were placed in the centre of each area to supply power to all railways, irrespective of whether they are separate companies or not, within such area. With the object of organising a uniform electrical system common to all companies, I would recommend the formation of a central directing Board consisting of members appointed by the railway companies, one representative for every 500 miles of railway or part thereof. After a period of investigation, this Board could finally select and adopt the system of electrification which they deemed to be the best one to be common to all the companies alike.

"England and Wales contain 58,370 sq. miles; if we average the area required for each power station at 900 sq. miles, the total number of power centres required would be 65. Each railway company could subscribe towards the capital cost of erecting the power centres and sub-stations, in the direct proportion or ratio of their respective train mileage recorded in the complete previous year's working. If the system ultimately adopted should be one of polyphase generation, serving direct current to the trains through sub-stations, I would advocate one such sub-station to every 36 sq. miles, making a total of 25 distributing stations for each power centre. The companies could provide their own equipment such as rolling stock, feeders high and low tension, third rail or trolley wires—in fact, all the plant necessary outside the power stations and sub-stations. The current taken by each company for their purposes could be measured by meter, and the payments due from each individual company could be ascertained and adjusted by the Railway Clearing House.

"To discover the total power required for working one section of 900 sq. miles, it is necessary to calculate the mean weight of each train along with the mean speed. In order to obtain the former, I have made inquiries from several reliable authorities, with the result that 200 tons per passenger train, and 350 tons per goods and mineral train, are safe figures to take. For passenger trains I have based the mean speed upon the time taken by 34 long-distance trains and 15 short-distance trains, taking Manchester as a centre. This I consider to be a fair average speed by passenger trains in England and Wales. The short-distance trains are taken to be within a 15-mile radius of Manchester at an average distance of 7½ miles. The long distance trains are taken to be without the 15-mile radius, at an average distance of 68 miles. There is no certain information to be ascertained as to the mean speed of goods and mineral trains, and for the purposes of this Paper I have taken this speed to be 15 miles an hour; with this traffic very considerable delays occur, such as shunting at stations to drop and take up waggons, running into sidings to clear for passenger trains, &c."

Mr. Bennett allows 18 passenger trains per day, with a speed of 24 miles per hour and a weight of 200 tons each, also 17 freight trains of 350 tons weight and 15 miles speed, and computes that the power stations, with ample allowance for losses and extra demands, and with complete duplicate plant, should be of 11,000 kilowatt capacity each. The cost of such a station is estimated at £1,416,000, and hence the cost of the total equipment would be a little less than £100,000,000.

Working out the cost of operation, using the data compiled by Mr. Langdon in his paper presented before the Institution of Electrical Engineers in November, 1900, allowing 3½ per cent. interest, Mr. Bennett computes this at a little less than £140,000,000 per annum. Comparing this with the present cost of operation by steam locomotives, it appears that a gain of 0.29 per cent. would follow the introduction of electric traction. In Mr. Bennett's paper these figures are worked out in detail, but the results are certainly sufficient, when the number of assumptions necessarily included are considered.

"Would this extra profit of 0.29 per cent. be a sufficient incentive for the companies to undertake this revolutionary departure? I am inclined to think that it would not, and yet to yield even this small amount of profit it is essential to treat, for purposes of electrification, the railway system as a whole, and in a properly organised way jointly, otherwise I feel pretty confident that the alteration or conversion could only be brought about by incurring a very heavy loss.

"The point now to consider is in what way could electrification be introduced to justify not only this large amount of expenditure, but to benefit the shareholders and all classes of the public alike. It has been proved beyond a doubt that where an accelerated and a more frequent service has been given, along with a generous reduction in fares, the traffic has increased fourfold. In this country and in Italy I believe this to be the case. If this large increase has been obtained with passengers, is it not likely to obtain also with goods and minerals? My opinion is decidedly in the affirmative.

"Now, assume that by gradual steps the railway companies were to reduce the passenger fares to one-half of the mean obtaining to-day—viz., to ½d. per passenger-mile, and the goods and minerals to ⅜d. per ton-mile, and to increase the long-distance speed to a mean of 50 miles an hour and the short-distance speed to 30 miles an hour, while at the same time doubling the train-miles by giving a more frequent service. The alteration would lead to an increase of traffic to at least threefold, if not more. The passenger load-factor at present of only 10 per cent. appears to be so ridiculously low that I think with a little differentiation it could be materially improved. It seems absurd to supply a conveyance weighing 200 tons to convey 2½ tons of people about, and that is what it really amounts to. The high peak of the suburban passenger load is when people are going and returning from business, consequently, for 10 or 12 hours out of the 18 the trains are running practically empty. Under these conditions one motor coach and perhaps a trailer would amply suffice during these periods of little traffic, instead of the 200-tons trains in use at the present time; therefore, with double the headway and an accelerated speed a far better passenger load-factor could be obtained. An alteration of this nature would solve many problems, the housing question being one of them. The alteration in the goods and mineral services would lead to the revival of many industries, besides bringing into being many new ones. It would be a boon of incalculable value to the agricultural interest. No longer would it be possible to send fruit and vegetables from the Continent to large Midland towns at lower rate than from our own producing counties; nor would it be probable that finished articles of commerce would be sent from New York via Liverpool to London at a lower rate as from Manchester to London, as the railway freights to London would be less, which is not so at the present time."

Reworking the computation upon the basis of 22 passenger trains per day at a speed of 40 miles per hour, and 20 freight trains at 25 miles per hour, the cost of electrification is increased to £150,000,000 and the annual cost of operation to about £22,600,000. This is computed to yield a gain of 1.831 per cent. upon the paid-up capital over that given by steam locomotive traction.

Mr. Bennett warns the railway companies from continuing in their present policy with regard to electrification.

"Indiscriminate installations are useless for proving whether electrification is economical. The only way by which electrical working can be made cheaper than the present method is by adopting one system common for all companies, controlled by one central body like the Railway Clearing House. There are six or seven railway systems in Manchester: would that centre not be a good one to test the system I advocate? Assuming that Manchester and 15 miles round were electrically equipped, the experiment could be made by reducing all the passenger fares to one-half within that radius; and if treble traffic resulted, my theory will have been proved to be correct. The next course to be pursued would be to electrify the whole of Lancashire in the same way, reduce the present fares and freights to one-half within the county, and if the expected results are realised, then the whole of England and Wales could be proceeded with."

THE ARTIFICIAL COOLING OF BUILDINGS.

THE AIR COOLING AND VENTILATING PLANT OF THE MUNICIPAL THEATRE AT COLOGNE ON THE RHINE.

Joseph Musmacher—Gesundheits-Ingenieur.

ALTHOUGH the artificial warming of buildings is one of the oldest of arts the use of mechanical methods of cooling the air in warm weather has been but little applied. Refrigerating machinery has been carried to a high state of perfection, but it has principally been applied to the production of such low temperatures as are necessary for the preservation of meats, and the cooling in breweries, so that the account of the air-cooling plant recently installed in the municipal theatre of Cologne is of especial interest. From a paper by the engineer of the city of Cologne, Herr Joseph Musmacher, published in a recent issue of the *Gesundeits-Ingenieur,* we abstract some account of this work.

Owing to its important position as a railway centre, Cologne receives a large number of foreign visitors during the warm season, and in order that the theatre might remain open during the warm weather it was decided to install such appliances as would insure the maintenance of a temperature not higher than 20° C. (68° F.) in the hottest part of the season. The variations in the external temperature rendered it necessary that the system should be under entire control. The presence of moisture in the air also formed a subject for regulation, so that a number of interrelated questions were involved.

Various methods of maintaining a moderate temperature were examined these including the cooling of the air by spraying finely divided water, or by the circulation of cool spring water through coils of piping arranged in the ventilating passages. Neither of these, however, appeared to offer a wholly satisfactory solution of the problem, and it was finally decided to maintain a circulation of cold brine through piping, using a refrigerating machine to abstract the heat.

Since the building was already completed, and provided with a heating and ventilating plant for winter service, it remained to adapt the cooling system to the passages and communication already in existence. In order that satisfactory results should be obtained it was necessary to provide for the movement of nearly four times as much air in the summer as is required in winter time. The plant was arranged to provide 35 to 40 cubic metres of air per hour per person, while in the summer time the air supply is taken at 130 cubic metres. It is estimated that each person emits 100 calories per hour, and this must be carried off by the cooled air in addition to the maintenance of the difference between 20° C. and the external temperature. Allowing 0.31 calorie for each centigrade degree per cubic metre of air a simple computation shows that the heat evolved by each person would raise the admitted air by 2.5° C., so that the air should enter the auditorium at a temperature not exceeding 17.5° C. if the limit of 20° C. for the temperature of the auditorium is not to be exceeded. The external atmosphere often reaches a temperature of 26° C., together with a relative humidity of 70 per cent., and the present plant is proportioned to take care of 82,000 cubic metres of air per hour under these conditions. A portion of the cooling is done by the use of coils of pipe through which cold spring water is circulated, and this air is delivered direct to the upper galleries. A part of the air, however, is passed over pipes containing brine which has been cooled to about 5° C., this causing a deposition of the moisture as dew, and thus drying the air as well as cooling it. The water drips from the pipes and is drawn off, and this chilled and dried air is mixed with the remainder of the incoming air in such proportion as to give the required temperature.

The original plan for heating and ventilating the house in winter provided for the admission of the warm air above and the suction of the foul air through openings beneath the seats of the spectators. A similar plan is adopted for the cooling plant, the air being drawn through filter screens by means of disc fans, and delivered to the cooling coils, while the warmed and ventilated air is removed through the ventilating openings in the floor.

In order to avoid the installation of an unnecessarily large refrigerating machine, a so-called "accumulator of cold" is employed, this consisting of a large tank, holding brine which can be cooled by running the refrigerating machine during the day and drawn upon to feed the cooling coils during the evening. The entire details of the installation appear to be very well worked out, and the plant affords an interesting precedent which may serve for the design of similar installations elsewhere.

It is a matter for surprise that artificial cooling has not been developed to a greater extent than at present appears. Thus in many warm countries such installations might prove of great value in connection with theatres, halls, and other places of public assembly. Especially in connection with hospital work, in the treatment of the diseases prevalent during the heated term, it might be practicable to provide the service with a powerful ally in treatment. Instead of resorting to local treatment with ice, the entire hospital could be maintained at any conveniently low temperature, while special rooms could be supplied with chilled, dried and sterilized air in any quantity and under closely regulated conditions.

Such possibilities may well be considered in connection with the great work soon to be undertaken at the Isthmus, and every method and appliance which science can furnish drawn into requisition to aid in the success of that undertaking.

PROGRESS IN AERIAL NAVIGATION.

THE DAWNING OF THE POSSIBLE SOLUTIONS OF THE PROBLEM OF THE MECHANICAL NAVIGATION OF THE AIR.

Octave Chanute—Popular Science Monthly.

ALTHOUGH a great number of attempts have been made to travel through the air by the aid of mechanical appliances, these may all be gathered into two main classes: navigable balloons, and dynamic flying machines. Both of these appear to be approaching some degree of successful solution, and hence the paper of Mr. Octave Chanute, himself a distinguished engineer and experimenter, published in a recent issue of the *Popular Science Monthly*, is timely and interesting.

Mr. Chanute reviews rapidly the progress made by the dirigible balloon during recent years, from the experiments of Giffard to those of Santos, Spencer, Barton, and Stanley. Nearly all the progress which has been made in this line of work has been due to the development of the light and powerful gasoline motor. Giffard, with a balloon 144 feet long and 39 feet in diameter, was able to carry a steam engine of only three horse power, and this motor weighed 462 pounds. The military balloon "La France" of Renard and Krebs, 165 feet long and 27½ feet in diameter, carried an electric motor of nine horse power weighing 1,174 pounds, but it proved much more manageable than its predecessors, and is was especially well shaped. The gas bag was parabolic in longitudinal section, somewhat like a cigar rolled to a sharp point at both ends, the largest cross section being one-fourth of the distance from the front. The balloon was driven, blunt end foremost, by a screw attached at the front of the car. In the opinion of Mr. Chanute, no better shape and arrangement have yet been devised, and subsequent experimenters who have wandered away therefrom have achieved inferior results, so far as the coefficient of resistance is concerned.

Mr. Chanute refers to the great military balloon of General Meusnier, built by the French government, and having a gas bag of 120,000 cubic feet capacity and a gasoline motor of 45 horse power. Although it is maintained that this powerful machine was never taken out, it is possible that this statement refers to the military trips which it might have taken had war occurred. With the improvements in light motors which have since been made, this balloon could carry a motor of 70 horse power, and probably attain a speed of 30 miles an hour, greater than that of present transatlantic steamers.

The later experiments of Zeppelin, Santos Dumont, Spencer, and others, are well known, and the experiments at the St. Louis exposition will doubtless do much to develop the limitations of this type of machine. Mr. Chanute reports that he has recently found in France a reaction against navigable balloons. It seems to be realized that the speed limit has nearly been reached, at least for the present, and that but small utility is to be expected from the dirigibles. They must be large, costly, and require expensive housing; while they are slow and frail, and carry very small loads. As commercial carriers they are not to be considered, but they may be useful in war and exploration.

Turning to the dynamic machines, Mr. Chanute examines briefly those designs which involve the use of lifting screws, but dismisses them upon the ground that they require relatively an enormous power compared with other machines. The form which appears to present the greatest opportunity for success is that of the aeroplane, in which the motive power is exerted to propel the plane forward, causing it to ride up upon the air. Three important series of experiments have been conducted upon this line, by Maxim, Ader, and Langley, and all three have been unsuccessful because the machines did not possess the required stability. The machine built by Sir Hiram Maxim at a cost of about $100,000, showed that it was capable of lifting itself and its motive power when a forward speed of about 36 miles per hour was attained, but its stability was imperfect and it was broken in the attempt. Similar results followed the trials of the machine built by M. Ader for the French War Department, and by Professor Langley, and all these experiments demonstrated the correctness of the theories with regard to the lifting and supporting power, while at the same time showing that greater stability must be provided together with thorough experience in balancing and managing the apparatus. As Mr. Chanute says, it appears paradoxical that a man shall be expected to acquire experience with a machine before he attempts to use it, but such is the case. The first efforts of a novice in riding a bicycle would lead one to imagine that perfect control of such a machine must be impossible, while the skill of experienced trick riders demonstrates what can be accomplished with practice and experience. There is no doubt that man must go through much the same experience as the young birds, and pass through the awkward stage of flopping about and falling to the ground before he learns to balance himself in the air.

The work of the Wright brothers with gliding aeroplanes has been reviewed more than once in these columns, and it is evident that these experimenters have gone about the task in the proper manner. It was only after three years' practical experimentation that Messrs. Wright felt themselves familiar enough with the manipulation of gliding aeroplanes to venture to add a motor, but from recent reports it appears that they have been successful in propelling their machine by artificial power and in keeping it under satisfactory control. There appears to be little doubt that the aeroplane problem has been practically solved, but in a manner different from that which has been expected, and the man who desires to use such a machine cannot expect to mount it as he would an automobile and ride off successfully, but rather must devote much time to his personal training as an equilibrist, and qualify himself as an adept. As Mr. Chanute well says:

"Now that an initial success has been achieved with a flying machine, we can discern some of the uses of such apparatus, and also some of its limitations. It doubtless will require some time and a good deal of experimenting, not devoid of danger, to develop the machine to practical utility. Its first application will probably be military. Whe can conceive how useful it might be in surveying a field of battle, or in patrolling mountains and jungles over which ordinary means of conveyance are difficult. In reaching otherwise inaccessible places such as cliffs, in conveying messages, perhaps in carrying life lines to wrecked vessels, the flying machine may prove preferable to existing methods, and it may even carry mails in special cases, but the useful loads carried will be very small. The machines will eventually be fast, they will be used in sport, but they are not to be thought of as commercial carriers. To say nothing of the danger, the sizes must remain small and the passengers few, because the weight will, for the same design, increase as the cube of the dimensions, while the supporting surfaces will only increase as the square. It is true hat when higher speeds become safe it will require fewer square feet of surface to carry a man, and that dimensions will actually decrease, but this will not be enough to carry much greater extraneous loads, such as a store of explosives or big guns to shoot them. The power required will always be great, say something like one horse power to every hundred pounds of weight, and hence fuel can not be carried for long single journeys. The north pole and the interior of Sahara may preserve their secrets a while longer.

"Upon the whole, navigable balloons and flying machines will constitute a great mechanical triumph for man, but they will not materially upset existing conditions as has sometimes been predicted. Their design and performance will doubtless be improved from time to time, and they will probably develop new uses of their own which have not yet been thought of."

AUTOMATIC TELEPHONE EXCHANGES.

ADVANTAGES AND SHORTCOMINGS OF PROPOSED SYSTEMS FOR DISPENSING WITH THE CENTRAL TELEPHONE EXCHANGE.

H. S. Knowlton—American Electrician.

EVER since the introduction of the telephone attempts have been made to devise some satisfactory system by means of which the users might be rendered independent of the central exchange. This is the more interesting because it is generally admitted that the exchange is what has made the telephone the commercial success which it is to-day. The original invention of Professor Bell, ingenious as it was, would have found but a limited application had it been confined to direct communication between two unvarying points, and it was the invention of the exchange which may well be considered as second only to the original device itself. Doubtless much of the effort to displace the central exchange has been due to defective service, but it is a question whether improvement may not better be made in the operation of the central system than by its displacement in favor of any so-called independent system. The entire subject is discussed very intelligently in an article by Mr. Howard S. Knowlton in a recent issue of the *American Electrician.*

In examining this subject it is desirable to understand just what is meant by an automatic system. Properly speaking, an automatic device is one which does not require human intelligence or service for its operation. In telephone parlance, however, it appears to be applied to devices which transfer the work of the central station to the subscriber.

"The automatic system requires the subscriber at least to set up the number which he wants by means of pegs, pins or cranks, and in some cases he is obliged also to ring up the other party to the conversation. These operations are simple enough to persons accustomed to accuracy, but it is another proposition to expect the public at large to grasp the sequence of operations and correctly to manipulate the delicate apparatus of an automatic system each time it talks by telephone. It is true that the annoyances occasioned by operators' mistakes, flippancies and thoughtlessness are eliminated in local traffic by the automatic exchange, but it is possible that other vexations may occur. It is not difficult to imagine the trouble which it would be to a business man in a large city to have to put his mind upon solving the puzzle of setting up numbers himself at some crisis of his affairs when every moment is of great value and every faculty of his mind required to be at its highest efficiency. Here is a chance for the most decided annoyance to enter, and if the private branch exchange be cited as a remedy it only removes the trouble a step further. Perhaps the most important function of the telephone lies in its time-saving qualities, and in the case of a subscriber who wants a large number of numbers in sequence, the inconvenience of setting up all these numbers himself, and probably ringing them up as well, is no imaginary burden."

In order to obtain a correct view of this phase of the question let it be supposed for the sake of argument, that the central exchange had not been devised, but that every subscriber had to attend to the details of making the connection every time he wished to use the instrument. Under such conditions it is not difficult to imagine that the bold innovator who ventured to invent and introduce the central exchange would be hailed with joy as the man who had delivered his fellow men from a great nuisance and enabled them to be served instead of having to wait upon themselves. An excellent example of the way the thing works in actual practice is seen in the extent to which the introduction of private exchanges has been developed. Although a number of offices, close to each other in the same office building may be most suitably arranged to admit the introduction of some mechanical system of making connections it has been found desirable to provide a small sub-exchange so that a cheap attendant may save this trouble and permit each user to have the annoyance of attention to the connection taken off his hands.

There is a growing tendency among the inventors of mechanical recording and accounting devices to make the operation of these depend to some extent upon the joint service of the customer. Thus the automatic cash registers, and fare indicators in street railways, assume that the purchaser or passenger is desirous of aiding the company in keeping tab on his employees, making of him a sort of extra clerk or even spotter, without so much as even asking his permission, and in a variety of ways this game is being worked, the indifference of the public being taken for acquiescence. In the case of the automatic telephone, however, this does not seem to be the case, since the pressure for the use of such instruments does not appear to emanate from the telephone companies, nor from the customers either, for that matter.

"It is doubtful if a great public service system like the telephone exchange can be entirely reduced to machine methods with the ready acquiescence of the public. Human nature is at each end of the line, and conditions are bound to arise where something more intelligent than machinery is needed to straighten matters out. Thus, in a conversation through an automatic central office the transmission may be imperfect and cannot be remedied without the delay of an appeal to the wire chief, whereas it might be possible for an operator in a manual exchange to suggest effective remedies or notify the trouble man at the very moment the difficulty was noticed. No mere machine, however intricate or wonderful, can possess intelligence, and that quality is one of the most vitally important characteristics of an efficient operator. An illustration of the public's attitude toward this is found in the antipathy which was shown to the use of the graphophone to inform a calling subscriber that the line sought was busy. This monotone repetition of the words, 'The line is busy, please ring off!' became so annoying to the public that the telephone companies are lately substituting other means of imparting this unwelcome information."

So far as practical experience has taught anything in telephone work it has been to show the desirability of relieving the user for everything possible. The mere taking of the receiver from the hook and calling for the desired number appears to have reduced the customer's portion of the work to a minimum, where it is most desirable that it should be retained.

"The whole trend of telephone practice has been toward greater simplicity in the subscriber's station and its operation; witness the replacement of the magneto generator and local battery by the common battery central-energy exchange. The first cost of this has been very high, sometimes a thousand dollars per foot in the central office multiple switchboard alone, but the reduced maintenance charges and increased satisfaction on the part of the subscriber have gone a long way toward justifying the change. It is hard to estimate the betterment of service produced by enabling the subscriber to call the central office simply by removing the receiver from its hook, as compared with the old method of grinding out signals through a sometimes cranky magneto."

Apparently the true way to improve telephone service is along the lines which have thus far proved so satisfactory, by developing the efficiency of the central exchange. It is difficult to see how human intelligence and service can be altogether avoided, but at least it can be reduced to a minimum and taken altogether out of the hands of the subscriber and concentrated among a class of operators especially trained for the worked and skilfully directed by competent supervision. Anything which, under the name of automatic service, transfers any of the detailed drudgery of making the connections to the hands of the subscriber should be regarded in its true light, and given some more fit name than the misnomer which is now attached to it.

THE REGULATION OF THE NILE.

LAKE MOERIS OF THE PHARAOHS AND THE MODERN BARRAGE AND RESERVOIR AND DAM AT ASSOUAN.

Sir William Willcocks—Khedivial Geographical Society.

MUCH has been said and written about the great dams and regulation works which have been constructed upon the Nile, and the interest which attaches to structures of such magnitude and importance is not to be minimised. The work is not completed, however, with the building of the great dam and its auxiliary structures, and many things yet remain to be considered in connection with the control of the great river. In a lecture recently delivered by Sir William Willcocks at Cairo, before the Khedivial Geographical Society, the whole question is fully examined, and some most interesting relation between the modern works and those of the ancient Pharaohs are given, the whole forming a study of the subject which will repay perusal.

In the first place, Sir William Willcocks admits that the Assouan dam, as at present constructed, while doing all that was expected of it, is not doing all that Egypt demands.

"The Assouan reservoir, at its present level, contains one milliard of cubic metres of water, which will suffice for the conversion of half a million acres to perennial irrigation, adding £15,000,000 to the wealth of the country. But though the dam was only completed at the end of 1902, already the whole of the water has been devoted to special tracts, and the government is reluctantly compelled to refuse all applications for water. This has been an unexpected blow to the country, which had been waiting patiently these six years for the long-promised reservoir. While the whole world is crying for that long-stapled cotton which in its highest grades is the specialty of Egypt, the Egyptian landowners of 1½ million acres are compelled to wait perhaps for many years, while every country under the sun which can grow cotton is trying to acclimatize their special product, and they themselves are doomed to sit idle."

Two things need to be done to provide the three milliards of cubic metres of water which are necessary. The dam at Assouan should be raised 6 metres, an addition for which provision has been made in the original design; and an auxiliary reservoir, a modern lake Moeries must be provided, to enable the additional water to be dealt out as needed.

The location of the reservoir, as Sir William Willcocks unhesitatingly affirms, is in the Wady Rayan, long ago pointed out by Mr. Cope Whitehouse as the proper site. This natural depression is admirably adapted, both by level and situation, for the purpose, being located in the desert to the south of the Fayoum, and separated from it by a limestone ridge. It has, at a level of about 29 metres above the sea, a surface of 700 square kilometres, or about one quarter the area of the ancient lake, which has been closely identified with the present Fayoum. Like the ancient lake, the lowest point of the Wady is 41 metres below sea level. When filled with water the greatest depth will be 70 metres. The uppermost four or five metres will be utilised annually, or some 3 milliards of cubic metres of water out of a total volume of 20 milliards.

"When the Assouan dam will have been raised we shall be standing on the threshold of what it will be able to do. The projected Wady Rayan reservoir, the modern lake Moeris, will be well able to supply the remaining two milliards of cubic metres of water when working in conjunction with the Assouan reservoir. The great weakness of this projected lake has lain in the fact that by itself it can give a plentiful discharge in April and May, less in June, and very little in July. But when the Assouan reservoir is capable of supplying two milliards of cubic metres of water it will be possible to utilise the lake to its utmost capacity. The Assouan reservoir, being high above the level of the Nile, can give its supply at the beginning or end of the summer; it can give it slowly or with a rush; while the projected lake Moeris, being directly in communication with the Nile, and only slightly above low Nile level, its discharge will depend entirely on the difference of level between it and the Nile, and consequently as the summer advanced it would gradually fall and would not be able to give at the end of the summer a quarter of the discharge it could give at the beginning.

"But let us imagine that the reservoir and the lake are both completed and full of water, and that it is the first of April. Lake Moeris will be opened to the Nile, and give all the water needed in that month, while the Assouan reservoir will be maintained at its full level. In May, lake Moeris will give nearly the whole supply and the reservoir will give a little. In June the lake will give little, and the reservoir much; while in July the lake will give practically nothing and the reservoir the whole supply. Working together in this harmonious manner, the reservoir and the lake, which are the true complements of each other, will easily provide the whole of the water needed for Egypt."

The lake can be used as a reservoir holding either two or three milliards of cubic metres of water; and, as projected for the larger quantity of three milliards of cubic metres, it will have a feeder canal from the Nile north of Sharaouna to the edge of the deserts north of the Mazura regulator on the Yusufi canal, and then along the edge of the deserts to the point where the Lake canal begins to traverse the deserts. This canal will be 30 kilometres long and will insure the lake being filled annually to a height of 31 metres above sea level if necessary; although it is estimated that a height of 29 metres above sea level will be sufficient. The 31 metre level will render the canal capable of relieving the Nile of 1,000 cubic metres per second for 50 days, or reducing its flood level by 30 centimetres for that period of time. The main lake canal will traverse the desert opposite Mayana, entering the Wady Rayan at its easternmost point, this forming the outlet from the lake, into the Nile, both canals being provided with the necessary regulators.

Sir William Willcocks gives estimates for the cost of the construction necessary to carry out the plan, showing that for an expenditure of £500,000 on the Assouan dam and £2,000,000 on the lake at Wady Rayan, an increase in the value of the irrigated land of £45,000,000 will result. He gives some interesting historical references, showing that there is great probability that the seizure of the controlling works of the ancient lake Moeris was the true origin of the famine of the days of Joseph, and shows that the relief demanded in modern times must be conducted along the lines which were found successful in the days of the Pharaohs.

"The great fact before us is the complete disposal, within 12 months, of the first milliard of cubic metres of water stored in the Assouan reservoir, and the eager demand for more from every quarter of the country. If the government had at its disposal to-day the 3 milliards of cubic metres of water which are still required, they would be disposed of within an incredibly short space of time. The area which could be put under cotton every year in the country, provided there was sufficient water available in summer, would be 2½ million acres. This area would insure 10 million cwt. of ginned cotton every year, as against 6 million cwt. to-day. Every acre of reclaimed land in Lower Egypt is specially suited to cotton. Such being the case, and the value of the water being so exceedingly great, and its storage so exceedingly easy, there is no reason why this storage should not be immediately undertaken.

"Four thousand years ago Egypt stood at the parting of the ways, and adopted a system of water storage and flood control suited to basin irrigation which served the country well for thousands of years. To-day Egypt stands again at the parting of the ways, and it may be her destiny to adopt a system of water storage and flood control suited to perennial irrigation which may stand her well for the thousands of years which may yet have to come."

HIGH-SPEED TOOL STEELS.

THE MANUFACTURE AND USE OF MODERN RAPID-CUTTING STEELS FOR USE WITH MACHINE TOOLS.

J. M. Gledhill—Coventry Engineering Society.

ALTHOUGH the use of the modern high-speed tools steels was received with what may almost be termed the cold-shoulder in Great Britain when the results of the work of Messrs. Taylor and White in the United States was first announced, this apparent indifference has now entirely passed away, and efforts are being made to show British engineers the importance and desirability of falling into line in this important development of modern industry. Among the firms which have entered upon the production and exploitation of the modern steels none has been more active and energetic than Messrs. Armstrong, and the results of their work have been well presented in a paper before the Coventry Engineering Society by Mr. J. M. Gledhill.

In the early portion of his paper Mr. Gledhill describes the various processes of making steel, and although this part of his address has no especial bearing upon the so-called high-speed steels, yet some of his remarks are of interest and value in this connection. Thus, the importance of providing the best of material is insisted on.

"It has been proved from long and extensive experience that the finest qualities of crucible steel can only be made by using the best brands of Swedish or Dannemora ores, and which, on account of their freedom from impurities—that is, their low percentages of phosphorus and sulphur—render them the most suitable for producing tool steels that will best retain their cutting edges. High percentages of phosphorus in tool steel (anything above .03% phosphorus would be considered detrimental) is as opposed to good steel as fire is to water. Of course, these Swedish irons are expensive, and the process of converting them into steel is slow and costly, as only comparatively small quantities of steel can be produced compared with the amount of fuel and labour expended. It therefore follows that the best brands of crucible steel must always command a high price, for it is impossible to satisfactorily produce them from inferior materials. You cannot produce good steel from bad materials, nor can you make bad steel into good steel, but conversely you can very easily make good steel into bad if you do not work and treat it properly; and, to sum up on these points, if a good article is to be produced in crucible steel, just as in everything else, good materials must be used and a fair price paid for the article."

"There is no royal road, so to speak, to the production of high-class tool steel, the first essential being the use of the highest qualities of raw material as a general basis, and together with this, care and skill in its melting and manufacture throughout, and still further where exceptional results are desired, the exercise of scientific research as to the proper compositions for the various tempers of tool steel suited to the specific purposes for which they are required."

Unfortunately Mr. Gledhill gives no details whatever of the composition or method of manufacture of the high-speed steel of Messrs. Armstrong, but this omission is the less important, since Messrs. Taylor and White, both in their patents and in the report of the investigation of their steel by the Franklin Institute, have described fully the composition and method of tempering such steels. Mr. Gledhill, however, gives some useful information as to the forging and preparation of the tools, which may be of interest in connection with the use of any of the modern steels.

"Having obtained the bar, it is necessary to cut off the required lengths; and this must be done at a forging heat. The lengths must not be broken off cold, as this tends to cause cracks in the bars. For forging, the steel should be placed in the fire, and slowly but thoroughly heated, taking care that the heating has penetrated to the centre of the bar, and then forged at a bright red heat. Whilst forging, the bar should not be allowed to get lower than a good red. After the tool is forged it should be laid down in a dry place and allowed to cool slowly. To harden the tool, the nose only, should be gradually, but fairly rapidly, raised to a white melting heat, and then cooled with an air blast. If during this heating the point of the nose becomes fused or melted, no harm whatever has been done.

"After grinding, which should be done on a wet stone, the tool is then ready for use.

"To obtain the maximum efficiency it is essential that the nose of the tool shall be raised to a white melting heat as described.

"Another method which may be described of preparing the tools is as follows:—

"Forge the tool as before, and when cold roughly grind to shape on a dry stone or dry emery wheel. The tool then requires heating to a white heat, just short of melting, and cooling in the air blast. This method also lends itself for cooling the tools in oil; before which the temperature has to be lowered from the white heat to a good red heat (1,600° F.) either by the air blast or in the open, and the tool then quenched out in oil. Tools hardened by the latter method are specially good where the retention of a sharp edge is a desideratum, as in finishing tools, capstan and automatic lathe tools, brass workers' tools, etc."

Mr. Gledhill gives a number of instances of the cutting capacities of high-speed steels, not only for lathe tools, but also for milling cutters and for twist drills, showing beyond doubt the correctness and reliability of the statements which have been for them, and concludes by showing the importance of the subject to the engineering industries of Great Britain.

"It cannot be denied that the question of high-speed cutting is one of national importance to our country, for if we are to remain successful and retain our position in the engineering world, we must not only possess the best and most modern designs of machine tools, but we must also produce the best qualities of tool steel to serve them to their utmost producing capacities, for it matters not how excellent the one may be if the other is a laggard; the one must be the reciprocal of the other as near as practically possible. Given this, we then place ourselves in the most favourable position for the rapid and economical production of our various manufactures, and for best meeting our opponents in the open field of competition. This is why the question is indeed a national one, and it should be our aim to use every effort and skill to develop our machinery and the tool steel in connection with it to their highest states of efficiency. Speaking for high-speed steel we must feel that we are only in the early stages of its manufacture and use, and that nothing approaching finality has been arrived at. When the steel maker looks at the innumerable alloys of whose behaviour and proportions when mixed with steel, so much has yet to be learned, and also to the infinite number of combinations and percentages of those alloys with steel, and the corresponding varied results obtained, it is easily seen what a large field of research there is yet to traverse."

RAILWAY DEVELOPMENTS IN CENTRAL ASIA.

AN EXAMINATION OF COMMERCIAL AND MILITARY TRANSPORT PROBLEMS FROM RUSSIAN AND BRITISH VIEWPOINTS.

Verein Deutscher Ingenieure—Society of Arts.

ABOUT two years ago we reviewed in these columns the development of the Transcaspian railway system of Russia, showing the extent to which it was planned to include connections with the projected Central Asiatic Railway connecting Orenburg in Russia with Tashkent in Turkestan, together with the bearing of these extensions to the trade and political conditions in Afghanistan. We now have further interesting papers upon the same subject, one being an article in the *Zeitschrift des Vereines Deutscher Ingenieure* by Engineer P. Romanow, admittedly prepared from Russian sources upon the development of the Central Railway of Asia, and the other a paper presented before the Society of Arts by Col. Sir Thomas Holdich upon the commercial relations of Great Britain with Afghanistan. Taken together, these important articles give a most interesting view of the progress which is being made in the re-exploitation of a part of the world, old in a historical sense, but new when considered as a field for the development which follows the locomotives and the flags of Europe.

Broadly, the system of railway development adopted by Russia for its territory in central Asia may be examined as two distinct lines. From Batoum, the Russian port at the eastern end of the Black sea, there is railway connection through Caucausia to Baku on the Caspian, this being the outlet for the petroleum of the great Baku district; the port of Baku being also connected with the general railway system of Russia. The so-called military railway in the Transcaspian district starts from Krasnowodsk, directly across the Caspian sea from Baku, and was completed as far as Samarkand as long ago as 1888, this line passing through Merv and Bokhara. Although this line was primarily built for military purposes, it has served to develop commercial importance, Samarkand being a city of 58,000 inhabitants, and an ancient trade centre.

During the past three years this line has been extended to Tashkend, the capital of the province of Syr-Darja, a city of more than 160,000 inhabitants, and from thence a branch has been extended to Andishan, in the centre of the cotton growing district of Turkestan. From Merv a branch railway has been constructed to Kuschk, on the frontier of Afghanistan, while another branch has been projected to Mesched, from Aschabad, a point further back on the line, Mesched being over the Persian frontier. All this system belongs properly to the Transcaspian railway, but to this has been projected the Central Railway of Asia, extending from Orenburg, on the Ural frontier, to Tashkend, this line passing through the provinces of Turgai and Syr-Darja, and connecting the territory beyond the Caspian directly with the main lines of Russia and with the Siberian railway. This road is now under construction, and when completed will have the effect of opening up a most important country.

In addition to this line, which is now rapidly being pushed, it has been planned to construct a connecting line further east, running from Kriwotschekowo, on the line or the Siberian railway, southward to Tashkend, and forming an immense loop close to the western frontier of China.

From the British point of view the most important portion of the system is that already constructed, extending down to Kuschk, on the frontier of Afghanistan. The British railway from India extends northward to Quetta, and has been prolonged to New Chaman, on the southern frontier of Afghanistan, and could readily be carried to Kandahar, were it not for the opposition of the Ameer of Afghanistan to the construction of any railway in his dominions. It is only about 70 miles from New Chaman to Kandahar, and only about 350 miles across to Kuschk, and if the objections of the Ameer to railways could be overcome it might readily be possible to have the all rail route to India completed.

But is it desirable to have the objections of the Ameer removed? In a general way Sir Thomas Holdich appears to think it would not be objectionable. Commercial considerations are hardly of sufficient importance to warrant this opinion, especially from the British point of view. The Russian government would be most willing to have the benefit of the mail subsidy to aid in operating its military lines, and England would doubtless gain in point of time, but there are other considerations.

Afghanistan has properly been regarded as a buffer between Russia and India, and in order to be a buffer it must be internally independent. While there is at the present time a strong and vigorous ruler in Afghanistan, it is altogether possible that a weak follower might readily yield to the desire of a strong power to betray confidence reposed in him. Apart from political and military objections, however, the idea of railway communication through Afghanistan offers many pleasing probabilities.

As Sir Thomas Holdich says, the country is a most interesting one with a favorable climate. The distance from London via Moscow to the Caspian, and thence by Herat to the Indian frontier is about 4,000 miles, which might be done in ten days, or under pressure in a week, this being a material reduction in time over the 17 to 20 days' steamer time from London to Bombay. Both countries should gain by the through traffic and by the opening up of points now practically inaccessible.

While many objections may be offered against the idea of railway communication with India by way of Russian territory, there is much to be said in its favour. Communication is not necessarily weakness; the Suez canal has shown that in some cases it may mean added strength, and surely with the progress of civilization the idea of strength in isolation cannot be seriously maintained. Possibly the completion of the rail communication may take place at some future date when Afghanistan shall have become wholly a part of the empire, and it it would not be dangerous then it is difficult to see why it should do so now.

THE MANAGEMENT OF RAILWAYS.

METHODS OF ORGANIZATION AND SYSTEMS OF MANAGEMENT OF AMERICAN RAILROAD COMBINATIONS.

A. M. Waitt—Railroad Gazette.

DURING the past decade there has been a development in railroad combinations which has had a distinct effect upon methods of organization and management, and it has become evident that existing systems must be still further modified if the best results are to be attained. In a recent issue of the *Railroad Gazette* we note a paper by Mr. Arthur M. Waitt which treats of this question in the broad and judicial manner which might be expected from an engineer of his experience and judgment, and some abstract of his views will be found suggestive and valuable.

"For many years past, with the slower growth of individual lines and the occasional absorption of a few small connecting roads, it has seemed possible to extend the system of organization in vogue on the principal line to those absorbed, and the general offices have gradually had placed upon them added duties and jurisdiction, until in far too many cases the roads are suffering from the absolute impossibility of those in the more responsible positions in the management being able to handle the work imposed upon them in the manner they had been in the habit of doing with a less extensive field to cover. In the greatly increased territory supervised, it is rarely possible for the general supervising officers to keep in touch with the details of a large system, as was perfectly possible with a single road.

"In some cases presidents, vice-presidents and general managers have endeavored to still carry the old burden of details, with one of three results. Either the system has developed in a one-sided way (the line in which the officer was originally trained) or the road has not developed satisfactorily, and is still lacking in system; or unfortunately the head of the system has paid the penalty of overwork with his life or broken-down health. The history of our American railroads has given many illustrations of this statement, and it is to be feared that more are to follow."

Mr. Waitt distinguishes clearly between the man of technical ability and the qualities which go to make up a good executive.

"The most successful man for the head of a department is not the man who can put in the most hours at a desk and who can work hard himself, but rather the one who has the faculty of keeping others at work to good purpose, and knows how to so keep in touch with his subordinates as to know what they are doing and to direct their general movements. It is not the general on the field of battle who wields his sword or shoots the most who is the greatest commander, but the one who from some vantage point can overlook the field of battle, note the movements of his regiments, and direct the dispatching of reinforcements to weakened points and plan strategic moves which will confuse and vanquish the enemy, at the same time standing ready in case of extreme urgency to unsheath his sword and go into the thickest of the fight to lead his men to victory."

With the entrance of railroad management into the field of great corporate combinations it must be realized that broader and more enduring methods must be followed, and that the principles of management must be based upon the same foundations as have proved successful in other lines of business.

"In the financial world large and influential corporations aim to so establish themselves that the continued success and stability of principles and methods will not be interfered with by death or continued absence of even the highest officers of the corporation. Similarly should the foundations be laid for our large railroad systems. This means, first, the establishing of a clearly defined and fixed general policy by the directors concerning the aims and future development and improvement of the system. Second, the selection of the best man obtainable to supervise the development of the system. Third, the determining of the best type of organization for producing the results desired. Fourth, the selection of the best men who can be obtained for department heads and subject to the general policy determined upon by the directors and chief executive, to give the department chiefs freedom, each in his own line, to develop the strongest organization and to produce the best results possible.

"It may be said that it is not safe to give such freedom of action; that the men selected may not be safely trusted with so much authority. The answer would be to get only the best, well-tried men obtainable, and then pay them as much as their type of services will command in any market outside of the railroad service. In this way the men selected will be anxious to do their best and to become fixtures with the company, instead of constantly hoping an opportunity will present itself in some other place to get a salary more commensurate with the services required and given. The knowledge of a man's past accomplishments should be reasonable assurance of his future possibilities.

"On this basis build an organization which will be noted for permanency of office and which will make a point of taking in young men of promising character and ability and of educating and developing them in their line of work so that after a period of five, ten or more years the necessity of looking outside for strong men to fill advanced positions will be obviated, by having at home well-trained and efficient men, thoroughly imbued with the fundamental principles on which the progress of the company was founded years before. In this way stability can be assured, strong railroad men educated and the highest type of results obtained. In this country, happily, there can be seen at least one or more examples of the results of over two decades of organized development on these lines, which speaks for itself."

In general, Mr. Waitt believes that the "departmental" plan is the best for large railroad systems, the board of directors themselves handling the financial matters and selecting the best obtainable men to manage the various phases of administration; these executive and administrative officers being ably and promptly supported in all reasonable calls for financial help. The board of directors should be divided into small committees, each with clearly defined relations to the various departments of the administrative work, and holding frequent stated meetings with the department heads.

These heads of departments should be

chosen with especial reference to their ability in their various lines of work and should be given full freedom of action in all matters pertaining to the specific details of their departmental organization, men, methods, and quality of materials used. Such executive officers should have sufficient skilled assistance as to relieve them from routine work, and all men in administrative offices should be paid such salaries as will give the system the pick of the best men in the country.

By having a carefully prepared schedule printed, giving complete definitions of the jurisdictions of the various departments and the authorities and duties of all the officers of the company, each man may be given full freedom of action within those limits and held wholly responsible for the results; continuance in office being known to be dependent upon those results. Such freedom and such responsibility may be regulated by the plan of holding regular monthly meetings of the department chiefs and the chief executive officer for the discussion of all questions of mutual interest and policy, and for the clearing up of difficulties which may have arisen.

Such are the broad outlines which Mr. Waitt suggests, and it will be seen that they are based upon such principles of common sense and business judgment which should commend them, not only to those who are interested in the successful conduct of railway affairs, but in many allied departments of productive work.

MACHINE TOOLS FOR ACCELERATED PRODUCTION

CHANGES IN MACHINE DESIGN AND IN METHODS OF DRIVING AND HANDLING DEMANDED BY THE NEW STEELS.

William Lodge—National Metal Trades Association.

IN mechanical engineering, as in many other lines of industry, it is almost impossible to change any one detail without involving many others in the change. The introduction of the new rapid cutting tool steels has been discussed from various viewpoints, but it cannot be considered by itself alone, since its influence has permeated all departments of work. In a paper presented before the National Metal Trades Association by Mr. William Lodge, and published in the *Iron Age,* some of these changes are examined in an interesting manner.

"There has never been a period in the history of the machine making industry comparing with the present in the matter of acceleration of pace of whole establishments. This has been brought about by the advent of high speed steels. Manufacturing establishments that formely got along reasonably well with the old methods of handling, storing, distributing and succession of the work in course of construction, will find it necessary to make a complete change in order that the various processes may uniformly keep abreast with each other in the rapid movement of the work going through the factory. High class mechanical engineers are necessary in order to lay out suitable stock rooms to receive in their proper proportion all goods that come under the class of merchandise and that are brought ready to go into the machines, such as cap screws, set screws, nuts, bolts, washers, taper pins, name plates, index plates, &c.

"Other means will become necessary for storing castings, botn large and small; also the means of taking care of bar stock, covering all the different grades and shapes, such as square and flat cold rolled, square and flat rough stock, &c. They should be arranged in such a manner that even boys or men of light build may readily handle them from the rack to the machines and out again. The stock room man must be in evidence, as must the receiving clerk, the routing official, for routing the work through the establishment and the conveying system for delivering the goods from the yards to the cranes of the shop and for rapid distribution to and from the various machines. Better arrangements must be had for laying out for tools throughout the factories, leaving more space for work around them. In this respect an utter and entire change will be necessary. Standard gauges and measuring instruments of all descriptions must be provided, and duplicate part systems of manufacture, making it possible for every piece to be made entirely without reference to the piece to which it is assembled must be extended."

Mr. Lodge points out that it is not only necessary to have machine tools properly designed as to strength and speed for the new steels, but that all the operative conditions must be arranged in accordance with the results which it is desired to attain. Many customers are dissatisfied because they are unable to obtain the results in their shops which have been guaranteed by the maker of the tools, while the trouble is not with the tools but with the conditions under which it is attempted to operate them. In such cases no good results can be expected unless the purchaser unites with the maker to secure the benefits which are within his grasp. There are to-day a number of able engineers whose entire business it is to advise as to the rearrangement and administration of workshops in order that the benefits of modern accelerated methods may be fully secured, and if the managers of shops desiring to keep up with the procession are unable themselves to do this work of reorganization, they may well obtain expert advice upon this as upon other questions.

High speed steels will stand up under heavy cuts at high rotative speeds, but that is all that they will do. They will not make lazy workmen industrious, neither will they make weak lathes strong nor light belts pull. They will not put the work into the lathe nor clear the chips away, and they cannot be expected to turn out work rapidly if the proper sizing is to be obtained by the cut-and-try method. To get the results of which they are capable it is necessary to have heavy and strong tools, fully powered and properly equipped with handling facilities. Furthermore they include the services of intelligent and ambitious workmen, remunerated upon some wage system which offers sufficient incentive for them to get out the best that is in them, together with such skilled supervision as will eliminate altogether the necessity for any guess work on the part of the workman regarding the speed or feed to be employed for any piece of work. In other words they form but the initial element in the modern system of accelerated production, a system which means greater returns both to employer and employee, and which, properly managed, places the establishment in which they appear so far ahead of the old time shop that the two are not to be mentioned in the same day.

Although many statements as to the cutting capacity of the new steels have been made public, some of the facts given by Mr. Lodge may be given because of their practical nature. Thus he says:

"I have seen a lathe running 29 hours at 270 feet per minute, reducing bars of steel 3/12 inches in diameter to 3 inches at one cut, sufficiently true to be delivered to the grinding machine, and without regrinding the tool one single time during the entire period. This created a difference in the time of machining this piece from one hour under the old system down to 2½ minutes with the new, and produced a better piece of work. I have seen a tool stand up a solid hour on cast iron running 125 feet per minute and removing scale.

"Ordinary mild steel can be turned all day at 180 feet per minute with ¼ inch feed and ⅛ inch reduction. Cast iron rolls which formerly had never fewer than two, and frequently three cuts, are turned from the rough casting at one cut of 150 feet per minute, with ⅛ inch feed, ½ inch reduction, leaving the work nice enough to go to the grinding machine. In the matter of deep drilling of lathe spindles of 0.50 carbon, that formerly took five hours, we are now finishing the pieces in 30 minutes. The former speed of 40 revolutions per minute, boring a 1 9/16 inch hole, was changed to 400 revolutions per minute, and the feed from 3/1000 per revolution to 6/1000 per revolution."

These are but a few of the figures which might be cited to show the proportion of time saved by the use of the new methods of work, but such results can only be attained by the conjoined action of improved cutting tools, used in improved machines, fully powered, and attended by interested workmen under competent functional supervision. It is worse than useless for a proprietor to buy a new heavy power lathe, for example, together with a few bars of rapid tool steel and expect these to work a revolution in the shop by themselves. These things are but means to an end, and that end can be attained only by the energetic application of skilled effort.

THE STEAM ACCUMULATOR.

THE EQUALIZATION OF EXHAUST STEAM AND ITS UTILIZATION IN THE LOW-PRESSURE STEAM TURBINE.

Ch. Dantin—Le Génie Civil.

THERE are numerous instances in which the economy obtained by high ratios of expansion and the use of a vacuum cannot be obtained in steam machinery without involving losses or inconveniences which more than counterbalance the advantages. Thus in the case of winding engines for mines, or for pumps and other auxiliaries carrying steam nearly full stroke, there is a large amount of energy wasted in the puffs of exhaust steam, and the utilization of this, together with the gain from the vacuum obtainable by its condensation, is most desirable. In an article in a recent issue of *Le Génie Civil,* by M. Dantin, is given an account of the Rateau steam accumulator, by means of which these irregular puffs of exhaust steam may be equalized and the flow of steam thus obtained employed to drive a steam turbine.

The method of equalizing the pressure is that of providing vessels for the exhaust steam to pass through, these vessels containing a mass of heat absorbing material, sufficient to take up the excess heat at the higher pressures and give it out again to re-evaporate the steam which may have been condensed during the cooler portion of the strokes. Engineers are familiar with the manner in which the metal walls of steam cylinders thus act to condense and re-evaporate the steam, and this action, so disadvantageous in the cylinder, has been turned to advantage in connection with the utilization of the exhaust steam.

M. Rateau has designed his accumulator in several forms. One of these consists of a vertical cylindrical vessel, containing a number of trays of cast iron, these trays being made quite heavy, so as to provide sufficient mass for the absorption of the heat. The entering steam varies in temperature according to its varying pressure, and the masses of metal absorb that portion of the heat which is above the mean, and give it out when the temperature falls below the average. When heat is absorbed a portion of the steam is condensed and collects in the trays as water, the pressure being lowered to the average, while this water is re-evaporated and produces steam again to maintain the average pressure during periods of low temperature. In an installation at the Bruay mines (Pas-de-Calais), four such accumulators are in use, containing in all about 40 metric tons of cast iron. In this plant the pressure of exhaust steam from the large winding engines is equalized so that it only varies between 0.15 to 0.25 kilogrammes per square centimetre.

The steam which has passed through the accumulator comes out in what is practically a continuous flow, and is then delivered directly to the low-pressure turbine, which again exhausts into a condenser; and although the average power of the winding engines is only 175 horse power, the turbine produces 300 horse power from the exhaust steam; this being used for driving an electric generator.

Another form of accumulator devised by M. Rateau consists of a tank of water, into which the steam is discharged. The high capacity of water for heat renders it especially well adapted for the purpose, provided means are devised for bringing the steam into intimate contact with the mass. This M. Rateau has accomplished by the use of several internal flues through which the exhaust steam is passed and from which it is discharged into the mass of water.

Here the steam is condensed and thus raises the temperature of the water, the water boiling off into steam having the average temperature and pressure of the exhaust steam delivered to it. The water tank in this case acts in a manner similar to the reservoir of the so-called "fireless locomotive," except that this latter device was charged with hot water from a boiler.

While such devices must always be regarded as methods of making up the deficiencies of the machines to which they are attached, and not to be employed in new designs when better direct applications may be made, they will find numerous occasions for use in existing plants, to the manifest improvement in their economy.

THE ENGINEERING INDEX

"THE KEYSTONE IN THE ARCH OF APPLIED SCIENCE"

The following pages form a Descriptive index to the important articles of permanent value published currently in about two hundred of the leading engineering journals of the world—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every article.

(1) The full title,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published.

We supply the articles themselves, if desired.

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer and works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of any article referred to in the Index, together with all illustrations, can usually be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the journals indexed are given.

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CIVIL ENGINEERING

BRIDGES.

Arch.

The Masonry Bridge at Plauen, Saxony. Carl L. Palen. Illustrates and describes a masonry arch bridge which has a span of 295.2 feet. It will cost about $125,000. 2000 w. Eng Rec—March 26, 1904. No. 61733.

Concrete-Arch.

Some Concrete-Arch Bridge Construction on the Illinois Central R. R. Illustrations with brief description of interesting work. 1200 w. Ry & Engng Rev—March 12, 1904. No. 61396.

Drawbridge.

Counterbalanced Draw Span on the Chicago, Milwaukee & St. Paul. Illustrated description of a new structure at Milwaukee, made necessary by the widening of the channel crossed by the present drawbridge. 800 w. R R Gaz—March 11, 1904. No. 61362.

Opening-Bridge Over Barking Creek. Illustrates and describes a bridge on the Barking and Beckton Light Railway. A single-line bridge on the rolling bascule principle, worked by electric power. 1400 w. Engng—March 4, 1904. No. 61410 A.

Foundations.

Tower Foundations of the Manhattan Bridge Across the East River, New York City. Illustrated detailed description of the construction. 2800 w. Eng Rec—March 12, 1904. No. 61348.

Girders.

The Graphical Calculation of Flange Stresses in Girders and Trusses. Oscar Sanne. Explains a method worked out by the writer. Diagrams. 800 w. Jour W. Soc of Engrs—Feb., 1904. No. 61543 D.

Loading.

Frequency in the Loading of Railway Bridges. Discusses prevailing practice in regard to loading bridges, offering some criticisms. 1400 w. Engr, Lond—Feb. 19, 1904. No. 61155 A.

Long Span.

The Five-Hundred-Foot Channel Span of the Clairton Bridge. An illustrated sketch of a bridge at Clairton, Pa., of more than usual interest. 2500 w. Eng Rec—March 12, 1904. No. 61347.

New York.

Masonry Construction for the Blackwell's Island Bridge. Describes the construction of the piers and anchorages of this bridge, which will be the third, in order of completion across the East River at New York. Illustrated. 3000 w. Eng Rec—March 5, 1904. No. 61243.

The New Bridges Over the East River at New York (Die Neuen, im Bau Begriffenen Brücken über den East River vor New York). Dr. F. Reuleaux. A general description of the Williamsburg, Manhattan and Blackwell's Island bridges, with photographs and bird's-eye view of New York. 2500 w. Glasers Annalen—March 1, 1904. No. 61636 D.

Nova Scotia.

Substructure Work and Erection of the Shubenacadie Bridge. This railway bridge crosses the river five miles from its mouth, where it is subject to very high tides. The conditions are described and an illustrated description of the substructure work given. 4300 w. Eng Rec—March 26, 1904. No. 61739.

Pittsburg.

The Erection of the Monongahela River Bridge, Pittsburg. The present article illustrates and describes the general features, falsework, derricks, and erection of anchor arms. 3800 w. Eng Rec—March 5, 1904. Serial. 1st part. No. 61232.

Plate Girders.

Improvement of a Plate Girder Bridge at Hartford, Conn. Henry Robinson Buck. Read before the Conn. Soc. of Civ. Engrs. Illustrated description of changes made to remedy the dripping of greasy water on the sidewalks below. 1000 w. Eng News—March 24, 1904. No. 61707.

The Plate-Girder Approaches of the Clairton Bridge. Illustrates and describes details of the viaduct approaches of this bridge near Pittsburg. It is designed largely for steel mill traffic. 1800 w. Eng Rec—March 26, 1904. No. 61735.

Reconstruction.

Reconstruction of a Bridge on the Midland Railway Across the River Trent. Frank Horace Frere. Reprinted from Pro. of Inst. of Civ. Engrs. Describes the old bridge, the method of taking down and removal, and the erection of the new bridge, which is built entirely of steel, of lattice girders of the type known as the "Linville truss." Illus. 3000 w. R R Gaz—March 25, 1904. No. 61716.

Reinforced Concrete.

Melan Concrete Steel Bridge at Dayton, Ohio. Illustrates and describes a seven-arch bridge to be built across the Great Miami River. 1600 w. R R Gaz—March 4, 1904. No. 61246.

Renewal.

Renewal of a Bridge Over Rondout Creek on the West Shore Railroad. Illustrated description of a new bridge 1,228 feet long which presents many questions of adjustment to existing conditions, and must be built without interrupting traffic. 800 w. Ry Age—March 18, 1904. No. 61589.

St. Petersburg.

The Troitsky Bridge Over the Neva, St. Petersburg. Briefly reviews the history of the undertaking and gives an illustrated description. 3300 w. Engr, Lond—March 18, 1904. No. 61772 A.

Substructure.

Substructure of Marsh River Bridge. Herbert J. Wild. Illustrated description of the construction of the substructure of a bridge in Maine to replace a wooden bridge on the Knox and Lincoln Ry. 3700 w. Pro Am Soc of Civ Engrs—Feb., 1904. No. 61176 E.

Terminal.

A Proposed Solution of the Brooklyn Bridge Terminal Problem. S. S. Neff. Describes a plan that can be carried out without the purchase of land or very much alteration of the terminal building, and at comparatively small cost. 2800 w. Eng News—March 3, 1904. No. 61225.

Trusses.

Trusses with Three Chords (Dreigurtige Fachwerke). Karl Haberkalt. An examination of a variety of stiffened bridge trusses and suspension girders, with examples of their use. 7500 w. 4 plates. Oesterr Wochenschr f d Oeffent Baudienst—Feb. 20, 1904. No. 61679 D.

Viaduct.

Connecticut Avenue Bridge, Washington. Illustrations and description of a proposed viaduct to carry this avenue across the valley. The original design has been recently developed in beautiful details by W. J. Douglas. 1500 w. Ry Age—March 18, 1904. No. 61,588.

WATERWAYS AND HARBORS.

Bombay.

The Development of Bombay Harbor. Map, with information as to what is proposed at this place. 1000 w. Engr, Lond—Feb. 19, 1904. No. 61156 A.

Canals.

New York's New Canal System. Col. Thomas W. Symons. A review of the proceedings which led to the bill appropriating over $100,000,000 for canal improvement, with an outline of the work already begun. 2000 w. Marine Rev—March 10, 1904. No. 61386.

The Canalization of the Elbe and the Moldau. Illustrates and describes the system of canalization under construction. 1800 w. Sci Am Sup—March 26, 1904. No. 61722.

The Canal of Jonage. Enrico Bignami. Begins an illustrated description of a private enterprise which has cost $10,000,000. 2000 w. Engr, U S A—March 15, 1904. Serial. 1st part. No. 61459.

The Water Supply for the Danube-Oder Canal (Die Wasserversorgung des Donau-Oder-Kanales). Emil Grohmann. An exhaustive study of the watershed, with tables of the run-off of various districts, together with topographical map and profiles. Two articles. 12000 w. 2 plates. Zeitschr d Oesterr Ing u Arch Ver—Feb. 12, 19, 1904. No. 61640 each D.

Canal Traction.

Electricity in Internal Navigation (Die Elektrotechnik in der Binnenschiffahrt). H. Kareis. Discussing the practicability of the commercial application of electric towing to canals. 1500 w. Zeitschr f Elektrotechnik—March 13, 1904. No. 61665 D.

Dams.

Large Rolling Dams (Barrages Mobiles Cylindriques à Grand Portée). Réné Koechlin. Illustrating and describing the movable dams across the arms of the Main at Schweinfurth, Germany. Each dam is a cylinder of riveted sheet iron, which can be rolled up in time of flood. 2500 w. 1 plate. Génie Civil—Feb. 27, 1904. No. 61624 D.

Roller Dams (Ueber Walzenwehre). K. E. Hilgard. Illustrated description of the rolling movable dams at Schweinfurt-on-the-Main. Two articles. 2500 w. Schweiz Bauzeitung—Feb. 6, 13, 1904. No. 61645 each B.

Dredging.

Dredging at Loch Raven, Baltimore. Alfred M. Quick. Gives an illustrated description of the dredging plant, with an account of the troubles that led to the city doing its own dredging, and report of the amount saved. 2800 w. Eng Rec—March 5, 1904. No. 61235.

Floods.

Flood Damage to the York Haven Power Plant. O. P. Waters. An account of damage caused by the recent ice freshet on the Susquehanna River. 700 w. Eng Rec—March 19, 1904. No. 61472.

Flow.

Mean-Flow Determination (Die Mittlere Abflussmenge). H. Lauda. Discussing graphical and analytical methods of determining the mean discharge of a stream for a given period of time. 3000 w. Oesterr Wochenschr f d Oeff Bandienst—Feb. 27, 1904. No. 61677 D.

Hydraulic Lock.

The Hydraulic Lock on the Trent Canal at Peterborough. Walter J. Francis. Illustrated description of this lock, designed to take the place of ordinary locks where great differences in elevation are found in a comparatively short distance. Claims a saving of time, economy of water and increased capacity. 4500 w. R R Gaz—March 25, 1904. No. 61717.

Levees.

The Improvement of the Portage Levee System. Prof. Leonard S. Smith. Describes the topography of the vicinity, stating what has been done to protect the land from the overflow, the faults of the work, and the improvements needed. Ill. 4500 w. Wis Engr—Feb., 1904. No. 61183 D.

Quay Wall.

Quay Wall at Delfzijl. An illustrated description of a design used in the Netherlands to accommodate vessels at low tide. 1300 w. Engr, Lond—Feb. 19, 1904. No. 61158 A.

Suez.

The Improvement of the Terminal Harbors of the Suez Canal (Die Seehäfen des Suez-Kanales und deren Verbesserungen). Illustrating and describing the new works at Port Said and Suez. 3000 w. Glasers Annalen—Feb. 15, 1904. No. 61632 D.

Wharf Crane.

Electric Bridge Crane of Ten Tons Capacity (Elektrisch Angetriebener Portal drehkran von 10,000 kg. Tragfähigkeit). Heinrich Rupprecht. Illustrating a powerful crane recently erected in the harbor of Stettin. An electric radial crane is mounted upon a fixed bridge spanning the railway tracks. 1200 w. Zeitschr d Oesterr Ing u Arch Ver—Feb. 19, 1904. No. 61641 D.

CONSTRUCTION.

Beams.

Flexure of Long Beams. H. Reissner. A criticism of a paper by Albert E. Guy, with a reply from Mr. Guy. 2000 w. Am Mach—March 10, 1904. No. 61327.

Building Collapse.

Causes of the Darlington Hotel Collapse. Drawings and further notes illustrating the points brought out in the report of H. deB. Parsons. 600 w. Ir Age —March 24, 1904. No. 61576.

Causes of the Darlington Hotel Collapse. Report of H. deB. Parsons, summarizing the causes of the collapse. 1500 w. Ir Age—March 17, 1904. No. 61557.

Collapse of Ten Stories of an Iron and Steel Frame Structure. Illustration, with account of the collapse of the Darlington Hotel, in course of construction on 46th St., New York. 1500 w. Ir Age—March 10, 1904. No. 61256.

Concerning the Fall of the Darlington Building. Editorial on this disaster, outlining the history of the case and commenting upon it. 3300 w. Eng News—March 24, 1904. No. 61709.

The Collapse of the Darlington Apartment House in New York City. A statement of the general circumstances as known, with discussion of the construction work, and the possible causes of the collapse. Ill. 3000 w. Eng News—March 10, 1904. No. 61352.

The Darlington Hotel Collapse in New York City. Description of this disaster, with editorial comment. 3000 w. Eng Rec —March 12, 1904. No. 61351.

Building Construction.

The Erection of the Wall Street Exchange Building, New York. Illustrated description of a steel cage building about 100 feet square and 327 feet high from sidewalk to top of roof beams. 2000 w. Eng Rec—March 5, 1904. No. 61231.

Chimneys.

Chimneys. Charles L. Hubbard. Some points on the determining of the height, form and size of chimneys. 1800 w. Am Elect'n—March, 1904. No. 61210.

Concrete Piles.

Concrete Piling. An illustrated description of the method of utilizing concrete piles in the improvements made at the Washington Barracks. The concrete is rammed into an iron pipe, which is subsequently withdrawn. 600 w. Sci Am—March 26, 1904. No. 61719.

Domes.

Theory of the Spherical Dome with a Homogeneous Surface, and of the Framed Dome; also Notes on the Construction of Masonry and Metal Domes. Irving P. Church. Discussion of E. Schmitt. 2200 w. Pro Am Soc of Civ Engrs—Feb., 1904. No. 61178 E.

Fire Protection.

Baltimore's Conflagration. An illustrated account of the fire that destroyed $85,000,000 worth of property, with opinions of prominent architects. 5200 w. Ins Engng —Feb., 1904. No. 61519 C.

Fireproof Buildings in the Rochester Fire. Explains the conditions existing in the burned district, discussing the damage. About $3,000,000 of property was destroyed. Ills. 1800 w. Eng News—March 10, 1904. No. 61353.

Lessons of the Baltimore Fire. F. W. Fitzpatrick, in *Fireproof*. An interesting account of the strange freaks of the fire, the materials that best withstood the intense heat, and lessons of importance taught by the disaster. 5400 w. Sci Am Sup—March 12, 1904. No. 61374.

Report to the Chief of Engineers, U. S. A., on the Baltimore Fire. John Stephen Sewell. Reports observations made with the view of arriving at some measure of the efficiency of current methods of fireproofing under some tests. 6500 w. Eng News—March 24, 1904. No. 61708.

Standard Regulations for Fire-Proof Buildings. Abstract of the National Board of Fire Underwriters' suggestions to be incorporated in building laws. 4200 w. Eng Rec—March 26, 1904. No. 61741.

Theatre Cut-offs and Fire Protection. Robert Palm. Discusses prevailing conditions and the requirements for proper protection. 2800 w. Ins Engng—Feb., 1904. No. 61520 C.

The Chicago Theatre Fire. Edwin O. Sachs. Gives facts relating to the burning of the Iroquois Theatre. 3200 w. Engng —Feb. 26, 1904. No. 61307 A.

The Lessons of the Rochester Fire. An illustrated article, with map of the burned district and study of the conditions. 2000 w. Ir Age—March 17, 1904. No. 61432.

The Protection of Fireproof Buildings Against Exposure Fires. Editorial review of the Baltimore and Rochester fires, and the lessons taught by them. 1800 w. Eng News—March 17, 1904. No. 61451.

The Report of an Expert. Views of E. C. Shankland of Chicago Concerning Steel Structures in the Baltimore Fire. Ills. 3400 w. Ir Age—March 24, 1904. No. 61574.

Foundations.

Caisson Foundations for a Large Steel-Cage Office Building on Broadway, New York. Describes in detail foundations of 29 caissons carried down to hard pan, and the methods used. Ills. 2200 w. Eng Rec —March 5, 1904. No. 61234.

Foundations of the Rogers Building, New York. Describes difficult foundation work for a ten-story steel-cage department store at the southeast corner of 14th street and 6th avenue, New York. 1800 w. Eng Rec—March 19, 1904. No. 61473.

Timber Crib Foundations. George B. Francis. Illustrated article describing the construction of timber cribs for different purposes in various parts of the United States. Plates. 4000 w. Jour Ass'n of Engng Socs—Feb., 1904. No. 61776 C.

Pile Drivers.

Improved and Combination Collapsible Pile Drivers for Railroad Work. Illustrated descriptions of various types. 2400 w. Eng Rec—March 19, 1904. No. 61470.

Plastering.

Difficulties and Methods of Plastering in Winter. D. L. Haigh. Considers the causes of trouble and the means of avoiding them. 3000 w. Eng Rec—March 5, 1904. No. 61238.

Roads.

Road Making in Buxton, England. John Hatton. On the making of tarred macadam roads. Ills. 1800 w. Munic Engng —March, 1904. No. 61173 C.

Road Making in Massachusetts. Asa Goddard. Gives the history of the work under the State aid laws, explaining the duties and methods of the commissioners. 1800 w. Automobile—March 12, 1904. Serial. 1st part. No. 61389.

Tunnels.

The Hudson River Tunnel. Gives a résumé of the principal events in the history of the enterprise now approaching completion. The junction between the New Jersey and New York sections was made March 11, 1904. Ills. 1500 w. Sci Am. March 26, 1904. No. 61721.

The Simplon Tunnel (Simplon Tunnel). The twenty-first quarterly report of the progress of the work, showing the tunnel to be about 91 per cent. of the distance through the mountain. 1500 w. Schweiz Bauzeitung—Feb. 13, 1904. No. 61647 B.

The New York and Brooklyn Tunnel for the Rapid Transit Railroad. An illustrated detailed description of the tunnel being constructed to connect the Broadway extension of the New York Rapid Transit Railroad with the Brooklyn Subway, passing under the East River. 2500 w. Eng Rec—March 5, 1904. Serial. 1st part. No. 61242.

See also Railway Engineering, Motive Power and Equipment.

MATERIALS OF CONSTRUCTION.

Cement.

Engineering Problems in Portland Cement Manufacture. S. B. Newberry. Explains the different classes of hydraulic cements and the making of Portland cement. Ills. 2200 w. Wis Engr—Feb., 1904. No. 61182 D.

Plant and Buildings of the Hecla Portland Cement & Coal Co. Illustrated detailed description of the plant at Bay City, Mich. 2500 w. Eng News—March 10, 1904. No. 61356.

Portland Cement. E. Kuichling. Considers its uses in various engineering constructions, reviewing its history and rapid developments. 4000 w. Munic Jour & Engr—March, 1904. Serial. 1st part. No. 61193 C.

The Works of the Egyptian Portland Cement Company. Illustrates and describes the methods used at a new marl cement mill, situated at Fenton, Mich. Gives plan and section, showing the arrangement of the plant. 2000 w. Eng Rec—March 12, 1904. No. 61346.

Concrete.

Concrete in Mining and Metallurgical Engineering. Henry W. Edwards. Information concerning the ingredients and construction of concrete, cost, treatment, uses, &c. Ills. 6500 w. Trans Am Inst of Min Engrs—Feb., 1904. No. 61572 C.

Effect of Clay on the Strength of Concrete. From *The Stone Trades Journal*. Gives results of tests for the comparative strength of Portland-cement concrete containing various portions of clay. 1000 w. Am Archt—Feb. 27, 1904. No. 61121.

Decayed Stonework.

Treatment of Decayed Stonework. A. H. Church. A memorandum upon the treatment of the decayed stonework of the Chapter House at Westminster. How to arrest the further process of decay. 2700 w. Quarry—March, 1904. No. 61288 A.

Piles.

Strength of Piles. C. S. Bihler. Read before the Pacific Northwest Soc. of Engrs. Gives results of some recent tests concerning the strength of long timber columns. Tabulated results, with explanatory notes. 4500 w. Ry & Engng Rev—March 12, 1904. No. 61397.

Reinforced Concrete.

A Reinforced Concrete Stable. Illustrated description of a stable recently built in New York. 2000 w. Eng Rec—March 19, 1904. No. 61475.

Destruction Test of a Considère Parabolic Girder (Essai à Outrance d'une Poutre Parabolique du Système Considère). Henry Lossier. Results of a test of a 20-metre span with wire-wrapped members, showing the high resistance of the system. 2000 w. Schweiz Bauzeitung—March 12, 1904. No. 61648 B.

Ferroinclave: A Fireproof Building Material. H. F. Cobb. Gives an illustrated description of this material as made for roofing and other uses, and its manufacture. 3000 w. Jour Ass'n of Engng Socs—Jan., 1904. No. 61529 C.

Reinforced-Concrete Bridge at Soissons (Pont en Beton Armé à Soissons). Full detailed account of three-span arch skew bridge across the Aisne at Soissons, constructed according to the Hennebique system. 3000 w. Plate. Génie Civil—Feb. 13, 1904. No. 61620 D.

Tests of the Adhesion and Initial Stress of Steel in Concrete. Sam. W. Emerson. A summary of results from a series of tests made. 1000 w. Eng News—March 10, 1904. No. 61354.

The Construction and Use of Concrete-Steel Piles in Foundation Work. Illustrated detailed description of the principal forms which have been employed. 4500 w. Eng News—March 10, 1904. No. 61355.

See also Civil Engineering, Bridges.

Timber.

Fungi in Mining Timber. Jules Elsner. An illustrated article, showing the growths that attack timber and discussing means of overcoming the trouble. 900 w. Ir & Coal Trds Rev—March 4, 1904. No. 61-422 A.

Wood Preservation.

The Preservation of Wood from Fire and Decay. Joseph L. Ferrell. Explains a method of impregnating and enameling wood, claiming very satisfactory results. General discussion. 2500 w. Jour W Soc of Engrs—Feb., 1904. No. 61544 D.

MEASUREMENT.

Adjustments.

The Adjustments of the Engineer's Transit and Level. Howard C. Ives. Describes the methods of adjustment. 4000 w. Jour Worcester Poly Inst—March, 1904. No. 61534 C.

Anemometers.

Electricity Anemometry in the Sea Coast Artillery Service. M. C. Sullivan. Describes the methods of determining wind velocities. 700 w. Elec Rev, N. Y.—March 19, 1904. No. 61466.

Curves.

The Surveying of Curves in Irregular Ground (Die Absteckung von Kurven in Coupierten Terrain). Friedrich Lorenz. Comparing various methods of laying out railway curves and their utility under different conditions. 4000 w. Oesterr Wochenschr f d Oeffent Baudiest—Feb. 27, 1904. No. 61678 D.

Wind Pressure.

Experiments Upon the Pressure of Wind at the Eiffel Tower. Emile Guarini. Illustrates and describes the principle of an apparatus used by M. G. Eiffel at the tower bearing his name. 500 w. Sci Am—March 19, 1904. No. 61436.

MUNICIPAL.

London Drainage.

Extension of the London Main Drainage System. An account of added facilities for the disposal of storm water. 1000 w. Engr, Lond—Feb. 26, 1904. No. 61-316 A.

Manholes.

Standardizing of Subway Manhole Construction. Hugh C. Baker, Jr. Illustrated description of a system designed and patented and used, and last year used experimentally by the N. Y. Telephone Co. 700 w. Elec Wld & Engr—March 19, 1904. No. 61482.

Paris.

The Champ de Mars and the Machinery Hall (Le Champ de Mars et la Galerie des Machines). E. Hénard. A protest against the proposition to devote the former exposition ground to building purposes, and a plea for its retention for public uses. 3000 w. Génie Civil—Feb. 27, 1904. No. 61625 D.

Pavements.

Details of Street Pavements in Salt Lake City, Utah. Drawings and extracts from the specifications used for paving First South street. 1000 w. Eng Rec—March 26, 1904. No. 61736.

Wood Pavement on New York Streets. Frederic Arnold Kummer. Gives information concerning the specifications, and reports remarkable durability. Ills. 1700 w. Munic Jour & Eng.—March, 1904. No. 61195 C.

Sewage Disposal.

Design for Septic Tank (Vorschlag einer Faulkammer). H. Schnack. Plans for septic tank and filters for 10,000 liters of sewage in 24 hours by intermittent treatment. 1500 w. 1 plate. Gesundheits-Ingenieur—Jan. 10, 1904. No. 61666 D.

Septic Tank and Broad Irrigation for Sewage Disposal at the Provincial Jail, Victoria, B. C. Brief illustrated description. 500 w. Eng News—March 3, 1904. No. 61221.

The Biological Disposal of Sewage from Isolated Buildings. Prof. Frank Clowes. Deals with the application of the biological method of treatment to the sewage from the new colony established at Horsham. Ills. Also discussion. 11,800 w. Jour Roy Inst of Brit Archts—Feb. 20, 1904. No. 61398 C.

Sewer Joints.

A Sulphur-Sand Composition for Pipe Sewer Joints. Alexander Potter. Reports the writer's use of this material, and tests made. Also states other advantages, and gives information concerning cost. 1500 w. Eng Rec—March 12, 1904. No. 61350.

Sewers.

A Large Concrete and Brick Storm Sewer in Newark, N. J. Illustrates and describes important sewer work to provide additional capacity for storm water. 1400 w. Eng Rec—March 12, 1904. No. 61349.

Construction of a Joint Trunk Sewer System in the Valleys of the Rahway and Elizabeth Rivers, New Jersey. An illustrated description of an extensive sewer system serving ten municipalities and having a length of over 23 miles. 5200 w. Eng Rec—March 5, 1904. No. 61233.

WATER SUPPLY.

Artesian Wells.

Atlantic City's Artesian Well Supply. Kenneth Allen. An account of improvements completed and projected for increasing the supply. Ills. 800 w. Munic Jour & Engr—March, 1904. No. 61194 C.

Distilling Plant.

Water-Distilling Plant for Egypt. Illustrated description of two exceptionally large plants for erection and service at Suakim, where they will supply pure water for drinking and boiler use. 1200 w. Engr, Lond—March 4, 1904. No. 61419 A.

Filtration.

A Concrete-Steel-Construction Filtration Plant for the New Haven Water Company. An illustrated description of unusually interesting filtration works. A slow sand filter plant. 3600 w. Eng Rec —March 5, 1904. Serial. 1st part. No. 61230.

A Filtration Plant for Harrisburg, Pa. The water supply is taken from the Susquehanna River, and the conditions are described; also the new filtration plant. 1600 w. Eng Rec—March 19, 1904. No. 61471.

Filtration from the Hygienic Standpoint. Dr. E. G. Matson. Remarks on the diseases usually attributed to impure water, and the value of filtration as a remedy. 2700 w. Pro Engrs Soc of W Penn —Dec., 1903. No. 61537 D.

Illustrated Description of Some Filter Plants and Results. Morris Knowles. 8500 w. Pro Engrs Soc of W Penn—Dec., 1903. No. 61539 D.

Open or Covered Filters? Frans Engstrom. Shows how the problem has been solved in Sweden where the climate is much colder, and gives opinions of expert engineers. 1800 w. Pro Engrs Soc of W. Penn—Dec., 1903. No. 61540 D.

High Pressure.

A Proposed High Pressure Water Supply System for Fire Protection in Chicago. Abstract of a report made to the commission appointed to consider the matter. Presents a plan, the main conduit to be a tunnel beneath the bed of the Chicago River with lateral terminals, &c. Ills. 2500 w. Eng News—March 3, 1904. No. 61220.

Gas Power for High-Pressure City Fire Service. J. R. Bibbins. An illustrated article describing conditions in Philadelphia, the high-pressure pumping station and matters related. 6000 w. Cassier's Mag—March, 1904. No. 61579 B.

High-Pressure Water Service for Fire Protection in New York. Slightly condensed report by Nicholas S. Hill, Jr., on proposed service. 2000 w. Eng Rec—March 19, 1904. No. 61476.

Report on Proposed High Pressure Fire Service for Borough of Brooklyn, New York City. I. M. de Verona. Considers the districts where the service should be installed, the relative advantages of fresh and salt water, cost, &c. 4200 w. Eng News—March 24, 1904. No. 61711.

Report on Proposed High Pressure Fire Service for Borough of Manhattan, New York City. Nicholas Hill. Outlines such a service and gives an estimate of cost. 2000 w. Eng News—March 24, 1904. No. 61710.

Irrigation.

An Irrigated Sugar Plantation in the Sandwich Islands. C. H. Kluegel. Describes the Oahu Plantation as a type. All the water is taken from wells and delivered by pumping. 700 w. Eng News—March 17, 1904. No. 61454.

Desert Irrigation in the Far West. L. R. Freeman. Showing the wonderful results brought about by irrigation. Ill. 2500 w. Rev of Revs—March, 1904. No. 61171 C.

Indian Irrigation and Famine. Reviews the report of the Commission appointed to inquire into and report in regard to the extent and benefit of the irrigation works, results as a relief from famine, &c. 2000 w. Engr, Lond—March 11, 1904. No. 61510 A.

Magdeburg.

The Water Supply of Magdeburg (Zur Wasserversorgung Magdeburgs). H. Peters. Describing the provision of a supply of ground water for the city of Magdeburg, Prussia, to replace the polluted supply from the Elbe. 2500 w. Gesundheits-Ingenieur—Feb. 29, 1904. No. 61668 D.

Paris.

The Supply of Potable Water for Paris (Alimentation de Paris en Eau Potable). J. Bergeron. Report upon future possible sources of supply, with map and hydrologic charts, with especial reference to the Orleans valley. 10000 w. 1 plate. Mem

Soc Ing Civ de France—Jan., 1904. No. 61675 G.

Pipes.

The Strength of Large Pipes (Zur Festigkeit Weiter Rohre). Dr. Philipp Forchheimer. An examination of the forces acting upon pipes of large diameter, including the deformations due to the weight of the pipe and its contents, and the earth pressure as well as the internal pressure. Two articles. 4500 w. Zeitschr d Oesterr Ing u Arch Ver—Feb. 26, March 4, 1904. No. 61642 each D.

Pumping Station.

Kirtland Street Pumping Station of the Cleveland Water Works. Charles Goffing. Illustrated detailed description of the buildings and their equipment. 3800 w. Eng Rec—March 19, 1904. No. 61467.

The Philadelphia Gas Engine Pumping Station for Fire Service. Illustrated detailed description of this high pressure pumping station. 3800 w. Eng Rec—March 5, 1904. No. 61244.

3,000 Horse-power Gas Engine Pumping Station for High Pressure Service. J. R. Bibbins. An illustrated detailed description of the Philadelphia station, with information relating to it. 2500 w. Engr, U S A—March 15, 1904. Serial. 1st part. No. 61460.

Reservoirs.

A Concrete-Steel Reservoir for East Orange, New Jersey. Gives a description of this reservoir, which is somewhat novel in design, with illustrations of details. 2000 w. Eng Rec—March 26, 1904. No. 61737.

Progress on the Wachusett Dam of the Metropolitan Water Works, Massachusetts. An illustrated article giving information concerning this large dam at Clinton, Mass. 2000 w. Eng Rec—March 5, 1904. No. 61229.

Stream Pollution.

The Allegheny River, a Bacteriological Problem. Dr. W. H. Ingram. Considers the distribution of disease by impure water, especially typhoid fever, and shows this river to be a source of danger. As the conditions cannot be removed a filtering plant is urged. 5500 w. Pro Engrs Soc of W Penn—Dec., 1903. No. 61536 D.

West Riding Rivers. A series of papers dealing with the various phases of the task undertaken by the West Riding Rivers Board. 3500 w. Engng—March 4, 1904. Serial. 1st part. No. 61412 A.

Sweden.

The Water Supply and Sewerage of Swedish Cities (Ueber die Wasserleitungs und Kanalisationsanlagen der Schwedischen Ortschaften). F. W. Hansen. A general review of municipal waterworks and drainage, with table of data for the principal cities. 5000 w. Gesundheits-Ingenieur—Jan. 31, 1904. No. 61667 D.

Thawing.

Experience in Thawing Water Pipes by Electricity. Reports from several places of success in using this method. 1200 w. Eng News—March 17, 1904. No. 61449.

Thawing Frozen Service Pipes by Electricity. An illustrated explanation of the use of electricity for this purpose. 2000 w. Met Work—March 12, 1904. No. 61306.

Typhoid.

I. Typhoid Fever at Watertown, N. Y. Weston E. Fuller. II. An Epidemic of Typhoid Fever in East Minneapolis. Frederic H. Bass. Two papers reporting investigations made to determine the causes of these epidemics. 3000 w. Eng News—March 3, 1904. No. 61224.

Waste.

The Measurement, Consumption and Waste of Water in the Boston Metropolitan District. Extracts from a valuable report by Dexter Brackett, engineer of the distribution department. 3000 w. Eng Rec—March 19, 1904. No. 61474.

The Waste of Water. Gives the results of the Boston investigation showing the waste to be enormous, discussing some of the causes and the remedy. 2000 w. Ir Age—March 24, 1904. No. 61573.

ELECTRICAL ENGINEERING

COMMUNICATION.

Insulation.

"Gutta Gentzsch." Describes an insulating substance intended for use as a substitute for gutta percha in submarine cables. 2000 w. Elec Rev, Lond—Feb. 26, 1904. No. 61299 A.

Printing Telegraph.

The Siemens & Halske Rapid Printing Telegraph (Schnellwirkender Typendruck-Telegraph von Siemens & Halske A. G.). Wilhelm v. Siemens. A fully illustrated account of the improved apparatus capable of transmitting 2,000 characters per minute. 7500 w. Elektrotech Zeitschr—March 10, 1904. No. 61660 B.

The Steljes Printing Telegraph (Der Steljes Ferndrucker). H. Lindow. An improved form of printing telegraph using the alternating current. 3000 w. Elektrotech Zeitschr—Feb. 25, 1904. No. 61655 B.

Pupin System.

The Success of Loaded Lines in Telephony. On the applications made of Dr. Pupin's invention, the difficulties met, and success attained. 1100 w. Elec Wld & Engr—March 5, 1904. No. 61332.

Rapid Telegraphy.

A New System of Rapid Telegraphy. Describes the system recently invented by Patrick B. Delany, designed to transmit and receive messages at the rate of 1000 words a minute over distances of 1.000 miles. 900 w. Sci Am—March 26, 1904. No. 61720.

Sight Transmission.

Tele-Electroscopy. From *L'Electra*. An account of the investigations made recently by Adriano Nisco, of Naples. Ill. 1500 w. Aust Min Stand—Feb. 11, 1904. No. 61500 B.

Space Telegraphy.

Improved Receiver for Wireless Telegraphy (Nouveau Récepteur pour la Télégraphie Sans Fil). N. Vasilesco Karpen. A communication to the French Academy describing a form of suspended needle which responds to the passage of electric waves. 1000 w. Comptes Rendus—Feb. 22, 1904. No. 61650 D.

The Transmission of Electric Energy Without Wires. Nikola Tesla. An account of the writer's work and expectations. Ills. 2500 w. Elec Wld & Engr—March 5, 1904. No. 61330.

Space Telephony.

Photo Telephony. Shelford Bidwell. Reviews what has been accomplished in this field, especially recent work of Mr. Ernst Ruhmer. 1200 w. Nature—Feb. 18, 1904. No. 61119 A.

Submarine.

Some Light on the History of the Submarine Telegraph. Baker A. Jamison. An account of the discovery of the insulating properties of gutta percha, and of its successful application to the needs of submarine telegraphy, and the wrong done the discoverer. 2700 w. Sci Am Sup—Feb. 27, 1904. No. 61125.

Submarine Sound Telegraphy. Gives an illustrated description of perfected apparatus for the transmission and reception of bell sound vibrations through water from one vessel to another. 1100 w. Sci Am—Feb. 27, 1904. No. 61122.

Sub-Stations.

The Telephone Substation. Arthur V. Abbott. The present article deals with induction coils and sub-station circuits. Diagrams. 1500 w. Elec Wld & Engr—March 26, 1904. Serial. 1st part. No. 61753.

Telegraphy.

The Progress of Telegraphy During the Past Thirty Years. William Maver, Jr. An interesting review of the progress during the past thirty years. 2200 w. Elec Wld & Engr—March 5, 1904. No. 61337.

Telephony.

A Review of Twenty-five Years of Telephony. Arthur Vaughan Abbott. 2500 w. Elec Wld & Engr—March 5, 1904. No. 61339.

Brighton Municipal Telephones. Illustrating and describing the laying of the underground ducts and the construction and operation of the exchange; with details of the switchboards, and map of the area served. 3400 w. Elec Engr, Lond—March 4, 1904. No. 61404 A.

DISTRIBUTION.

Choking Coils.

Design of Choking Coils for Alternating Current Circuits. Considers the elementary principles and formulae used in this connection, and discusses the design. 2000 w. Elec Engr, Lond—March 11, 1904. No. 61495 A.

Regulating Impedance Coils: Experiments Illustrating the Importance of Some Details in Construction. C. Faraday Proctor. Read before the Newcastle Loc. Soc. of the Inst. of Elec. Engrs. Gives results of experiments in the use of choking coils for regulating currents. 1800 w. Elec Engr, Lond—March 11, 1904. No. 61493 A.

Conduit Work.

The Conduit Work at the New Power House of the Edison Electric Illuminating Company, Boston, Mass. Illustrates and describes the plan of a large system having 96 ducts. 1600 w. Elec Rev, N. Y.—March 5, 1904. No. 61271.

Converters.

The Pulsation of the Continuous Current of Rotary Converters (Die Pulsation des Gleichstromes Rotierender Umformes). R. Elsässer. A graphical analysis of the relations of the continuous and alternating currents in a rotary converter showing the causes of pulsation. Single-phase and polyphase currents are discussed. 6000 w. Elektrotech Zeitschr—March 3, 1904. No. 61656 B.

Distributing Systems.

I. Overhead High-Tension Distributing Systems in Suburban Districts. George H. Lukes. II. Automatic Apparatus for Regulating Generator and Feeder Potentials. E. J. Bechtel. III. Safeguards and Regulations in Operation of Overhead Distributing Systems. W. C. L. Elgin. Three short papers discussed together. 10000 w.

Trans Am. Inst of Elec Engrs—Jan., 1904. No. 61552 D.

Earth Resistance.

Earth Connections. W. Moon. Gives information of value concerning the resistance of various materials and discusses the placing of earth-plates. 1600 w. Elec Rev, Lond—March 18, 1904. Serial. 1st part. No. 61764 A.

Group-Switches.

The Use of Group-Switches in Large Power Plants. L. B. Stillwell. Information concerning the group-switch as used in the plant of the Manhattan Ry Co., N. Y., given as introductory to a discussion. Diagram. 1300 w. Trans Am Inst of Elec Engrs—Jan., 1904. No. 61549 D.

Insulation.

Rubber Insulation. Some points on means of determining the value of rubber compounds for insulating purposes. 1200 w. R R Gaz—March 18, 1904. No. 61456.

Oil Switches.

Oil-Switches for High Pressures. E. M. Hewlett. Compares the oil-break switch with the air-break switch, as introductory to a discussion. 350 w. Trans Am Inst of Elec Engrs—Jan., 1904. No. 61550 D.

Switchgears.

Types of Direct-Current Low-Tension Switchgears. W. E. Warrilow. Illustrates and describes various types. 2200 w. Elec Engr, Lond—March 11, 1904. Serial. 1st part. No. 61494 A.

Wiring.

Notes on Interior Wiring. Arthur B. Weeks. Suggestions for the wiring of buildings for electric lighting. Ills. 1600 w. Am. Electn—March, 1904. No. 61213.

ELECTRO-CHEMISTRY.

Analysis.

The Electrolytic Analysis of Gold. F. Mollwo Perkin and W. C. Prebble. Describes experimental investigations, giving results. Ill. 2000 w. Elec-Chem & Met—Feb., 1904. No. 61546 E.

Development.

The Development of Industrial Electrochemistry. Dr. E. F. Roeber. Aims to bring out some general principles which have manifested themselves during the development of the electrochemical industries. 4500 w. Elec Wld & Engr—March 5, 1904. No. 61333.

Electric Smelting.

The New Swedish Electric Furnace Plant for the Manufacture of Steel. Frank C. Perkins. Illustrated description of the steel plant at Gysinge, Sweden, where the Kjellen electric furnace is used. 1800 w. Elec, N Y—March 16, 1904. No. 61399.

Electrolysis.

See Mining and Metallurgy, Copper.

Electroplating.

Electroplating Upon Aluminum. Chas. F. Burgess and Carl Hambuechen. Describes an interesting method of applying a coating that sticks. 1200 w. Electro-Chem Ind—March, 1904. No. 61257 C.

Welding.

Notes on Aluminum Welding. Sherard Cowper-Coles. Discussion of this paper which was read before the Faraday Society, Feb. 2, 1904. Ills. 2000 w. Elec-Chem & Met—Feb., 1904. No. 61547 E.

ELECTRO-PHYSICS.

Conductors.

A Résumé of Our Knowledge of the Physical Properties of Current-Bearing Matter. Dr. Paul R. Heyl. Considers the changes in matter produced by electricity, and cases where no such change occurs. A study of conductors and electrolytes. 3800 w. Jour Fr Inst—March, 1904. No. 61179 D.

Dielectrics.

Conductivity of Dielectric Liquids Under the Influence of the Radium Rays and of the Roentgen Rays. M. P. Curie. Paper presented to the Academy of Sciences. A report of researches. 700 w. Sci Am Sup—March 5, 1904. No. 61285.

Electro-Capillarity.

Electro-Capillarity. An experimental study made by C. Christiansen of the movements and changes of a globule of mercury in an electrolyte, and of falling drops of mercury in an electrolyte. 2000 w. Elec Rev, Lond—Feb. 19, 1904. No. 61144 A.

High Frequency.

Suggestions for Producing High-Frequency Currents and Some of Their Phenomena. Edwin F. Northrup and Elliott Woods. An account of what the writers have done with high-frequency apparatus, how they constructed it, and the phenomena observed. Ills. 2700 w. Elec Rev, N Y—March 19, 1904. Serial. 1st part. No. 61464.

Magnets.

The Letter of Peregrinus on the Magnet, 1269. Translation of a letter written in August, 1269, explaining the principle of the magnetic motor. 4400 w. Elec Wld & Engr—March 26, 1904. No. 61752.

Radio-Activity.

A Note on Mineral Containing Radium in the Province of Quebec. J. Obalski. An illustrated description of an ore specimen taken from a white mica mine. 700 w. Eng & Min Jour—March 17, 1904. No. 61446.

Thorium: A Radioactive Substance with Therapeutical Possibilities. Samuel G. Tracy. From the *Medical Record.* Gives photographs taken with varying degrees of exposure, and much information concerning this substance. Reports its use in treating tuberculosis. 1500 w. Sci Am Sup—March 5, 1904. No. 61284.

A Study of the Radio-Activity of Certain Minerals and Mineral Waters. R. J. Strutt. Read before the Royal Society. Gives results of an examination of certain radio-active materials, explaining method. 2500 w. Nature—March 17, 1904. No. 61759 A.

GENERATING STATIONS.

Alternators.

The Design of Alternators. H. F. Parshall and H. M. Hobart. Sets forth a method of designing founded upon experimental data. Diagrams. 5800 w. Trac & Trans—March, 1904. No. 61319 E.

Boosting.

The Advantages of Boosting. Frank Broadbent. Considers the use of boosters in charging accumulators. 1200 w. Elec Rev, Lond—Feb. 26, 1904. No. 61298 A.

Commutation.

Commutation of Continuous-Current Generators. G. A. Neild and P. E. Banting. Read before the Rugby Engng Soc. Deals only with machines having slot-wound armatures and carbon brushes. 4500 w. Mech Engr—Feb. 27, 1904. No. 61294 A.

Composite Plant.

A Composite Plant at Bloomsburg, Pa. L. S. Levy. Brief illustrated description of a plant utilizing the power of Fishing Creek Falls, and installing a 300 horse-power engine for use in times of low water. 1000 w. Elec Wld & Engr—Feb. 27, 1904. No. 61111.

Costs.

Some Notes on the Cost of Generating Electrical Energy. E. J. Fox. Points connected with cheap production are discussed with the view of showing that very economical results can be obtained. 3000 w. Engr, Lond—Feb. 26, 1904. Serial, 1st part. No. 61318 A.

The Cost of Electricity in Private Plants. Editorial review of paper by R. E. Fox, read before the Cleveland Inst. of Engrs. 1700 w. Engng—March 11, 1904. No. 61505 A.

Dynamos.

On Turbo-Dynamos. Prof. Dr. F. Niethammer. Outlines the electrical and mechanical difficulties which arise in the design of dynamo-electric generators directly connected to steam turbines of 500 to 4000 r. p. m. Ills. 2000 w. Elec Wld & Engr—March 19, 1904. Serial. 1st part. No. 61480.

The Evolution of Dynamo Design. David B. Rushmore. An illustrated article reviewing the early history of dynamo design, and discussing direct-current generators and alternators. 4500 w. Elec Wld & Engr—March 5, 1904. No. 61342.

Exposition Plant.

Service Power Plant of the Louisiana Purchase Exposition. Illustrated description. 5000 w. Elec Wld & Engr—Feb. 27, 1904. No. 61112.

Generating Set.

Enclosed Steam-Engine and Dynamo. Illustrated description of a compact arrangement of enclosed, self-lubricating, compound steam-engine, coupled direct to a continuous-current dynamo for lighting or power purposes. 1000 w. Engng—March 11, 1904. No. 61504 A.

Historic Station.

The First Central Station for Incandescent Lighting. W. J. Hammer. An account of the first installation of the Edison "Jumbo" dynamo in the 3,000-light central station on Holborn Viaduct, London, started on Jan. 12, 1882. 1700 w. Elec Wld & Engr—March 5, 1904. No. 61341.

Hydro-Electric.

Hydro-Electric Installation at Newry. Illustrated description of a plant built to utilize a fall in this river. The current supplies arc and incandescent lights and motors geared to various machines in English manufacturing works. 2000 w. Engng—March 4, 1904. No. 61416 A.

Hydro-Electric Stations of the Alta Italia Company. E. Bignami. A fully illustrated account of the hydro-electric stations supplying current to Turin and the surrounding country. 4000 w. Engineering Magazine—April, 1904. No. 61686 B.

The Kubel Electric Station (Das Elektricitätswerk Kubel). F. Collischon. A fully illustrated account of the plant utilizing the hydraulic power of the Urnäsch, near St. Gall, Switzerland. There is 2,000 h. p. taken from the river and distributed electrically in the neighborhood. Two articles. 7500 w. Elektrotech Zeitschr—Feb. 25, Mar. 3, 1904. No. 61654 each B.

Municipal Plant.

The Electricity Works and Destructor of the Metropolitan Borough of Hackney. Illustrated description of a successful and economical plant. 1500 w. Elec Rev, Lond—March 11, 1904. Serial. 1st part. No. 61496 A.

Parallel Running.

Alternators in Parallel. H. Bohle.

Read before the Leeds Loc. Sec. of the Inst. of Elec. Engrs. A treatise on this subject, discussing the most important problems. Diagrams. 2400 w. Elect'n, Lond—March 4, 1904. Serial. 1st part. No. 61407 A.

Review.

Dynamo Construction in 1903 (Der Elektromaschinenbau im Jahre 1903). Josef Löwy. A review of improvements in continuous and alternating machines during the past year. Serial. Part I. 1800 w. Zeitschr f Elektrotechnik—Feb. 21, 1904. No. 61662 D.

Seattle.

The Seattle Municipal Light and Power Plant. R. E. Heine. Illustrated description of a plant under construction for furnishing light and power at Seattle, Washington. 2200 w. Elec Wld & Engr—Feb. 27, 1904. No. 61109.

Sparking.

What Ailed the Dynamo? D. H. Browne. An amusing account of dynamo troubles and the search for the cause, with editorial. 2500 w. Elec-Chem Ind—March, 1904. No. 61258 C.

Storage Batteries.

The Storage Battery in Small Central Stations. J. M. S. Waring. Read before the Northwestern Elec. Assn. Considers the application to small stations and features common to all central stations. 1500 w. Elec, N. Y.—March 23, 1904. No. 61513.

Zanesville, O.

A Modern Railway, Light and Power Plant. An illustrated account of the reconstruction of the property of the Zanesville Railway, Light and Power Company. Equipped with both steam and water turbines. 1200 w. Elec Rev, N. Y.—March 19, 1904. No. 61463.

LIGHTING.

Development.

Expansion and Changes in Electric Light and Power Systems. Alton D. Adams. Gives statistics and data of interest showing the great increase of capacity. 3000 w. Elec Wld & Engr—March 5, 1904. No. 61338.

Incandescent Lamps.

The Beginnings of the Incandescent Lamp. Thomas A. Edison. A very interesting account of the writer's early work in this field and final success. 1300 w. Elec Wld & Engr—March 5, 1904. No. 61331.

Intensity.

The Relations Between Temperature and Intensity of Light (Ueber den Zusammenhang zwischen Lichtstärke und Temperatur). Hermann Eisler. A review of the experimental researches of Lummer, Kurlbaum and Langley, with curves showing the relation of increase of light with increase in temperature of incandescent bodies. 3500 w. Elecktrotech Zeitschr—March 10, 1904. No. 61659 B.

Mercury Vapor.

The Cooper Hewitt Mercury Vapor Lamp. P. H. Thomas. A lecture before the People's Institute at Cooper Union. An interesting description with brief account of some of the difficulties met with in its development. 2200 w. Elec Rev, N. Y.—March 19, 1904. No. 61465.

Philadelphia.

Electric Lighting in the City of Benjamin Franklin. W. C. L. Eglin. An account of the consolidation and reconstruction of the electrical supply interests with illustrated detailed description of the main generating station and its equipment. 3000 w. Elec Wld & Engr—March 5, 1904. No. 61329.

Photometry.

See Electrical Engineering Measurement.

Review.

A Quarter of a Century of Electric Lighting. Dr. Louis Bell. Some of the reasons for the rapid development of this enterprise and the factors which have produced it. 3000 w. Elec Wld & Engr—March 5, 1904. No. 61334.

MEASUREMENT.

Errors.

The Errors of Instruments. George T. Hanchett. Comments on errors in the types of measuring instruments used in electrical work and their causes. 2700 w. Cent Sta—March, 1904. No. 61391.

Galvanometer.

A Home-Made Sensitive Mirror Galvanometer. John D. Adams. Gives illustrations and directions for the construction of a galvanometer of the mirror or reflecting type. 1500 w. Am Elect'n—March, 1904. No. 61211.

Internal Resistance.

Measurement of Internal Resistance of a Battery by Ohm's Method. J. L. Dickson. Describes an interesting method. 450 w. Elec Wld & Engr—March 19, 1904. No. 61481.

Oscillations.

A New Method of detecting Electrical Oscillations. J. A. Ewing and L. H. Walter. Read before the Royal Society. An account of experimental investigations and a description of instrument. Ill. 1200 w. Elec Rev, N. Y.—March 26, 1904. No. 61731.

Oscillograph.

Some Uses of the Oscillograph. D. K. Morris and J. K. Catterson-Smith. Read at Birmingham Sec. of Inst. of Elec. Engrs. Describes a method of recording the magnetization curves of transformers during working, and other methods of measurement. 1000 w. Electn, Lond—Feb. 19, 1904. No. 61145 A.

Photometry.

The Development of Industrial Photometry. Prof. C. P. Matthews. On the improvements made in these measurements, the causes of errors, and the accuracy, methods and results now possible. 1200 w. Elec Wld & Engr—March 5, 1904. No. 61335.

Rheostats.

Calculation of Motor Starting Rheostats. F. Meurer and A. Simon. Gives the method of Prof. Görges for shunt motors, as given in *Elektrotechnische Zeitschrift.* 500 w. Elec Wld & Engr—March 12, 1904. No. 61382.

Testing.

Factory Testing of Electrical Machinery. E. R. Cross and R. E. Workman. The present number considers the organization, work and equipment of the testing department. Ill. 3000 w. Elec Club Jour—Feb., 1904. Serial. 1st part. No. 61186.

Windings.

Calculation of the Equivalent Ampere-Turns of Windings for Single and Polyphase Currents. C. F. Guilbert. The object is to deduce formulas of simple form for the cases apt to occur. 600 w. Elec Wld & Engr—March 12, 1904. Serial. 1st part. No. 61381.

MOTORS.

Alternating-Current.

The Alternating-Current Series Motor. F. D. Newbury. An explanation of its operation. 1800 w. Elec Club Jour—Feb., 1904. No. 61185.

Hire.

Should Electric Supply Undertakings Advance Motors on Hire or Hire-Purchase Systems? Sidney E. Britton. Read before the Glasgow Loc. Sec. of the Inst. of Elec. Engrs. Discussing both sides of this question, but favoring these systems. 2500 w. Elec Engr, Lond—Feb. 26, 1904. No. 61297 A.

Induction Motors.

Simple Computation Methods for Induction Motors (Einfache Berechnung von Drehstrommotoren) H. M. Hobart. Illustrating a modified form of the Heyland circle diagram. 1800 w. Zeitschr f Elektrotechnik—March 13, 1904. No. 61-664 D.

The Application of Induction Motors. Arthur B. Weeks. Illustrates and describes methods of application. 1200 w. Engr, U. S. A.—March 15, 1904. No. 61461.

Machine Driving.

See Mechanical Engineering, Machine Works and Foundries.

Mine Power.

See Mining and Metallurgy, Mining.

Motor Diagrams.

The Circle Diagram Applied to Oversynchronism (Das Kreisdiagramm für Übersynchronismus). Paul Müller. Showing the inapplicability of the circle diagram to induction motors when they are operated above synchronism. 2000 w. Elektrotech Zeitschr—March 3, 1904. No. 61657 B.

Motor Economy.

Small Gas Engines v. Electric Motors. Claims a saving by introducing the electric motors. 1000 w. Elec Rev, Lond—Feb. 26, 1904. No. 61300 A.

Motor Efficiency.

The Efficiency of Railway Motors (Die Motorleistung im Bahnbetrieb). M. Müller. A review of the theory of Zehme upon the influence of heating on the efficiency of motors. 1500 w. Elektrotech Zeitschr—March 10, 1904. No. 61658 B.

Repulsion Motor.

The Theory of the Atkinson Repulsion Motor (Theorie der Atkinson schen Repulsionsmotoren). M. Osnos. An exhaustive analytical and graphical analysis. Two articles, 6000 w. Zeitschr f Elektrotechnik—Feb. 14, 21, 1904. No. 61661 each D.

Single-Phase.

Single-Phase Commutator Motors and Their Regulation. Translation of a paper by Friedrich Eichberg, printed in the *Elektrotechnisch Zeitschrift.* The present number discusses phenomena appertaining to commutator machines. 2500 w. Elec Engr, Lond—Feb. 26, 1904. Serial. 1st part. No. 61296 A.

The Single-Phase Series Motor in Its Relation to Existing Railway Systems. Charles F. Scott. On the advantages of the single-phase system, and the adaptability of the apparatus to the old system. 1700 w. Elec Club Jour—Feb., 1904. No. 61184.

Speed.

The Rated Speed of Electric Motors as Affecting the Type to be Employed. H. M. Hobart. Read before the Inst. of Elec. Engrs. A study of continuous-current and induction motors, giving tabulated data of eleven designs, and conclusions. Ills. 3500 w. Elect'n, Lond—March 11, 1904. No. 61499 A.

The Rated Speed of Electric Motors as Affecting the Type to be Employed. Abstract of the discussion of paper by H. M. Hobart. 2700 w. Elect'n, Lond—March 18, 1904. No. 61765 A.

Speed Regulation.

Variable Speed Control. Budd Frankenfield. Begins a discussion of methods of controlling the speed of electric motors. 1500 w. Engr, U. S. A.—March 1, 1904. Serial. 1st part. No. 61214.

TRANSMISSION.

California.

The Yreka Light and Power Transmission. Leon M. Hall. An illustrated detailed description of this plant and its equipment. 2500 w. Jour of Elec—March, 1904. No. 61433 C.

Circuits.

Selection of Transmission Circuits. Alton D. Adams. Discusses points to be considered in the determination of the number of circuits that shall make up the line, and the relations of these circuits to each other. 4800 w. St Ry Rev—March 20, 1904. No. 61728 C.

High Pressure.

The 20,000-Volt Power Transmission Plant. A. J. Bloemendal. Illustrated description of plant at Lebring, Austria, in which 3,000 horse-power is transmitted 20 miles. Details of transformers and line are given. 2500 w. Engng—Feb. 26, 1904. No. 61308 A.

Lightning.

Lightning Protection. Ralph Scott. Considers principles involved, and gives brief illustrated descriptions of devices for the protection of telephones, signals and telegraph instruments. 1700 w. Elec, N. Y.—March 9, 1904. No. 61323.

Lines.

Calculation of Transmission Lines. Alton D. Adams. Gives principles and formulæ applying to the design of transmission lines for either continuous or alternating currents, explaining the calculations. 4500 w. Elec Rev, N Y—Feb. 13, 1904. No. 60843.

Switzerland.

The Electric Power and Transmission System of Schaffhausen, Switzerland. Begins an illustrated detailed description of this remarkable hydro-electric plant. 2300 w. Elec Wld & Engr—March 12, 1904. Serial. 1st part. No. 61379.

Transformers.

Predetermination of Transformer Regulation. Emerson G. Reed. Gives an empirical formula by which the inductance of the equivalent choking coil can be computed for a transformer of a particular type; also tabulated data on a line of commercial core-type transformers. 500 w. Elec Wld & Engr—March 12, 1904. No. 61380.

Terminals and Bushings for High-Pressure Transformers. Walter S. Moody. Considers the location and insulation of terminals in coils. Introductory to a discussion. 2000 w. Trans Am Inst of Elec Engrs—Jan., 1904. No. 61551 D.

The Relative Fire-Risk of Oil and Air-Blast Transformers. E. W. Rice, Jr. A short paper to introduce a discussion of this subject. 900 w. Trans Am Inst of Elec Engrs—Jan., 1904. No. 61548 D.

Voltage.

Voltage Regulation in Alternating-Current Systems. H. S. Meyer. Abstract of a paper before the Liverpool Engng. Soc. Aims to give a general review of some of the most important points, without entering upon a detailed consideration of the theoretical side. 3500 w. Elect'n, London—Feb. 19, 1904. Serial. 1st part. No. 61147 A.

GAS WORKS ENGINEERING

Address.

Presidential Address before the Midland Association of Gas Managers, Condensed. George Helps. Discusses the points of interest in the gas industry of England. 15000 w. Gas Wld—Feb. 27, 1904. No. 61295 A.

Air Gas.

The Production and Application of Air Gas (Das Luftgas, seine Herstellung und Verwendung). Dr. Walter Thiem. Describing a process of charging compressed air with hydro-carbon vapor for illuminating purposes. 3000 w. Glasers Annalen —March 15, 1904. No. 61637 D.

Burners.

Maintenance of Incandescent Gas Burners. E. Haase. Read before the Wis. Gas Assn. Gives facts from the writer's experience with report of cost. 1600 w. Am Gas Lgt Jour—March 7, 1904. No. 61264.

Explosions.

Gas Explosions. L. Bairstow and A. D. Alexander. Deals with results obtained by Mr. Grover when determining the effects of the products of combustion on the next explosion. 1300 w. Engng—March 11, 1904. Serial. 1st part. No. 61506 A.

Gas Flow.

The Motion of Gases in Pipes, and the Use of Gauges to Determine the Delivery. Richard Threlfall. States the hydraulic principles involved and reports careful investigations made of the points involved. Tabulated results. Ill. 4200 w. Inst of Mech Engrs—Feb. 19, 1904. No. 61313 D.

High Pressure.

High Pressure Distribution at St Margrethen. A, Rothenbach. Summary of a paper read before the German Gas Assn. Briefly describes the high-pressure gas distribution supplying the region at the southern end of Lake Constance. Ills. 1200 w. Gas Wld—March 19, 1904. No. 61763 A.

Incandescent.

Installation and Maintenance of Gas-Arc Lamps. T. H. Hintze. A paper before the N. E. Assn. of Gas Engrs., giving experience with an incandescent-mantle burner intended to compete with the electric arc. 1000 w. Am Gas Light Jour—March 7, 1904. No. 61263.

Mains.

The Laying of Mains and Services and the Recording of the Same. John Hellen. Read before the Michigan Gas Assn. Gives a summary of the methods used in Grand Rapids, Mich. 3500 w. Am Gas Lgt Jour—Feb. 29, 1904. No. 61106.

Producer Gas.

Producer Gas. Prof. A. Humboldt-Sexton. Considers the conditions a good producer must fulfill. Ills. 4300 w. Mech Engr—Feb. 27, 1904. Serial. 1st part. No. 61293 A.

Retorts.

A Method of De-scurfing Gas Retorts. Illustrates and describes apparatus, whereby a steam injector is utilized to introduce a mixture of steam and air. 1000 w. Gas Wld—Feb. 20, 1904. No. 61143 A.

Horizontal v. Inclined Retort Installations, with Notes on Coke Conveying. J. G. Newbigging. Read at meeting of the Manchester Dist. Inst. of Gas Engrs. Also discussion. Gives the writer's experience, with information in regard to first cost and maintenance, and all related questions. Ills. 11000 w. Gas Wld—March 12, 1904. No. 61491 A.

I. Inclines at New Bedford. C. H. Gifford. II. Inclines as Used at Lynn, Mass. C. F. Prichard. Ills. Two papers read before the New England Assn. of Gas Engrs. Describes the arrangement of inclined-retort plants and their management. 3800 w. Am Gas Lgt Jour—March 14, 1904. No. 61385.

River Lines.

The Laying of High and Low Pressure (River) Gas Lines. H. C. Morris. Read before the Michigan Gas Assn. Describes the laying of mains under the river, connecting gas works on both sides, at Saginaw, Mich. Ill. 3600 w. Am Gas Lgt Jour—Feb. 29, 1904. No. 61105.

Street Lighting.

The Illumination of Streets. Paul F. Gaehr. Briefly considers the best illumination, and method of testing. 1200 w. Sib Jour of Engng—Feb., 1904. No. 61189 C.

Water Gas.

Notes on Carburetted Water Gas Workings. H. Kendrick. Read before the Manchester Dist. Inst. of Gas Engrs. The paper is closely related to Mr. Newbigging's paper, and contrasts the cost of producing coal gas and carburetted water-gas, giving details of the latter process. 3500 w. Gas Wld—March 12, 1904. No. 61492 A.

INDUSTRIAL ECONOMY

Apprentices.

Apprenticeship Systems of the Allis-Chalmers Company. P. W. Gates. Describing a practical system, adjustable to widely diversified conditions. 2000 w. Engineering Magazine—April, 1904. No. 61683 B.

British Trade.

British Trade and Foreign Competition. T. Good. Aims to give an impartial statement. 2000 w. Cassier's Mag—March, 1904. No. 61583 B.

Chile.

The Industrial Future of Chile in Connection with the Panama Canal. G. Fred. Collins. A fully illustrated description of the country, its resources, development, and engineering opportunities. 3000 w. Engineering Magazine—April, 1904. No. 61682 B.

Coal Industry.

The Magnitude of the Coal Industry. Extracts from an address before the Modern Science Club of Brooklyn, by F. E. Saward. 3000 w. Sci Am Sup—Feb. 27, 1904. No. 61124.

Education.

Lessons in Engineering Education from America. Robert H. Smith. Reviews the paper of Dr. R. M. Walmsley, read before the Inst. of Elec. Engrs. 2400 w. Engr, Lond—March 11, 1904. No. 61509 A.

The Northampton Institute. Illustrated detailed description of one of the chief of the polytechnic and technical institutes of England, and account of the work. 9500 w. Engng—Feb. 19, 1904. No. 61149 A.

Exposition.

The Universal Exposition at Saint Louis, 1904 (L'Exposition Universelle de Saint Louis, 1904). Hugues Brussel. With plan of the grounds and numerous views of the buildings. 2500 w. Génie Civil—Feb. 20, 1904. No. 61622 D.

Labor.

High Unit Labor Cost and Its Effect on Prosperity. Thomas D. West. A very just presentation of the labor question and some of the mistakes. 2500 w. Ir Trd Rev—March 17, 1904. No. 61440.

How Should Organized Labor be Dealt With? J. Kirby, Jr. Address before the Philadelphia convention of the Nat. Met. Trds. Assn. Discusses the conditions in various places, and how best to meet them. 3200 w. Ir Age—March 24, 1904. No. 61578.

Miner's Wages.

The Assessment of a Miner's Wages. Discusses the provision in the Coal Mines Regulation Act of England. 2400 w. Engng—March 18, 1904. No. 61768 A.

Railroads.

The Influence of Railroads on Latin-American Stability. Edward P. North. Historical review showing the influence of frequent intercommunication brought about by railroads, and the tendency to develop stable governments. 1500 w. R R Gaz—March 4, 1904. No. 61245.

Wage Methods.

Wage-Paying Methods from the View-point of the Workman. Henry Hess. A graphical comparison of piece-work, bonus, and premium systems. 3500 w. Engineering Magazine—April, 1904. No. 61684 B.

MARINE AND NAVAL ENGINEERING

Armorclads.

Early Armorclads. Major C. Field. An illustrated review of early work in this field. 2700 w. Sci Am—Feb. 27, 1904. No. 61123.

Battleships.

Latest Battleships Mississippi and Idaho. W. F. Sicard. Information concerning two new battleships to be built for the United States. Ills. 2200 w. Marine Rev—March 10, 1904. No. 61387.

New 13,000-Ton Battleships Mississippi and Idaho, Nos. 23 and 24. W. F. Sicard. Compares some of the principal characteristics of these vessels with the Kearsarge and Alabama, and gives a detailed description. 4000 w. Jour Am Soc of Nav Engrs—Feb., 1904. No. 61782 H.

On the Offensive Powers of Recent Battle-Ships. Sidney Graves Koon. A study and a comparison. 2500 w. Sib Jour of Engng—Feb., 1904. No. 61188 C.

Cargo Steamers.

Possibilities of Design in Cargo Steamers. George Nicol. Considers ways in which the first cost of vessels may be reduced, and the advantages gained by care in the design of these steamers. 2000 w. Cassier's Mag—March, 1904. No. 61581 B.

Cruisers.

New Cruisers for the Japanese Navy. Information relative to two ships built for the Argentine Republic, but recently sold to Japan, and their official trials. Ill. 2800 w. Marine Engng—March, 1904. No. 61276 C.

Official Trial and Description of the Imperial Ottoman Cruiser Medjidia. Illustrated. 1800 w. Marine Engng—March, 1904. No. 61278 C.

The U. S. S. Denver. Com. W. H. Naumann. Illustrations, general description, and report of official trial. 8800 w. Jour Am Soc of Nav Engrs—Feb., 1904. No. 61784 H.

The U. S. S. Tacoma. Lieut. U. T. Holmes. General description, with report of official trial. 9000 w. Jour Am Soc of Nav Engrs—Feb., 1904. No. 61781 H.

U. S. S. Des Moines. Lieut. Walter Ball. General description, with report of official trial. 2300 w. Jour Am Soc of Nav Engrs—Feb., 1904. No. 61789 H.

Ferryboat.

New Canadian Screw Ferryboat. Illustration, plans, and brief description of a vessel under construction for service at Vancouver. 350 w. Naut Gaz—March 10, 1904. No. 61322.

Train Ferry Boat "Prince Christian" (Eisenbahn-Dampffähre "Prins Christian"). W. Kaemmerer. Illustrated description of new passenger train ferry boat for the railway service between Warnemünde, in Germany, and Gjedser, in Denmark. 1500 w. 1 plate. Zeitschr d Ver Deutscher Ing—Feb. 20, 1904. No. 61603 D.

Fleets.

A Comparison of the Russian and Japanese Fleets (Vergleich der Russischen und Japanischen Seestreitkräfte). A tabulated comparison of the respective fighting strengths at the beginning of the war. 3000 w. Schiffbau—Feb. 24, 1904. No. 61681 D.

Japanese Works.

The Mitsu Bishi Dockyard and Engine Works, Nagasaki, Japan. Illustrated description of these recently improved works, showing their capacity. 1500 w. Marine Engng—March, 1904. No. 61-277 C.

Launches.

The C. F. Herreshoff Speed Launch. Illustrates and describes a handsome launch on exhibition in New York. 600 w. Automobile—Feb. 27, 1904. No. 61107.

The Development of the High-Speed Launch or Automobile Boat. Shows two new motor-boat hulls designed by Mr. Sutphin Sutphin, and reviews the recent boats that have been built in the United States. 1700 w. Sci Am—March 12, 1904. No. 61371.

The Launch "Moguntia" of the Mainzer Rudder-Verein. Illustrated description of a fast German launch built of galvanized mild steel. 900 w. Sci Am Sup—March 5, 1904. No. 61286.

Lighterage.

Lighterage; Its Advantages and Disadvantages to the Port of New York. A. J. Grymes. An interesting illustrated description of the service, with lengthy discussion. 17600 w. N Y R R Club—Feb. 19, 1904. No. 61523.

Liner.

New Australian Liner Nikko-Maru. Illustrated detailed description of vessel built in Japan. 1800 w. Marine Engng—March, 1904. No. 61279 C.

Naval Machinery.

Improvement in the Installation and Fitting of Naval Machinery. Lieut. H. C. Dinger. A consideration of some of the lines along which improvements are to develop. 7800 w. Jour Am Soc of Nav Engrs—Feb., 1904. No. 61785 H.

Naval Strength.

The World's Naval Strength. Alfred Smith. A review of British naval strength as compared with other powers. 3500 w. Cassier's Mag—March, 1904. No. 61-584 B.

Paddles.

The Construction of Buckets of Feathering Paddle Wheels (Beitrag zur Konstruktion von Radschaufeln für Räder mit Beweglichen Schaufeln). W. Thele. Deriving a geometrical method for laying out the proper bucket shapes. 1500 w. Schiffbau—Feb. 10, 1904. No. 61680 D.

Petrol Motors.

See Mechanical Engineering, Internal-Combustion Motors.

Propellers.

On the Influence of Inward and Outward-Rotating Propellers on the Manœuvering Quality of Twin-Screw Vessels. Translated from *Mitteilungen aus dem Gebiete des Seewesens,* by Rear Admiral C. R. Roelker. 3700 w. Jour Am Soc of Nav Engrs—Feb., 1904. No. 61786 H.

San Francisco.

Ship Yards and Shipping of San Francisco. An illustrated review of the shipbuilding yards, with illustrations of some of the vessels. 2300 w. Marine Rev—March 17, 1904. No. 61477.

Ship Telegraph.

A New System for the Electric Operation of Dial Indicators (Ein neues System zur Elektrischen Uebertragung von Zeigerstellungen). W. Thiermann. An improved device for transmitting orders from the bridge or conning-tower of a ship to the engine room. 1800 w. Glasers Annalen—March 15, 1904. No. 61638 D.

Steamers.

New Steamer "Likelike." Illustrated description of a freight and passenger vessel designed for Hawaiian Inter-Island Trade. 600 w. Naut Gaz—March 24, 1904. No. 61599.

S. S. Mongolia—Pacific Mail Steamship Company. L. D. Lovekin. A description of the largest ship yet completed in America, with report of trial. 3900 w. Jour Am Soc of Nav Engrs—Feb., 1904. No. 61790 H.

Submarines.

Report of the Army Board as to the Usefulness of the Lake Type of Submarine Boat for Coast Defense. A summary of the military view of the usefulness of the submarine designed by Simon Lake. 2000 w. Sci Am—March 12, 1904. No. 61369.

Torpedo Boats.

U. S. T. B. Tingey. Rear-Admiral John D. Ford. General description with report of contract trial. 4500 w. Jour Am Soc of Nav Engrs—Feb., 1904. No. 61783 H.

Tow Boats.

Design for Twin-Screw Tow Boats. Drawings and description of a light-draught steel tow boat for use on western rivers. 1000 w. Marine Rev—March 10, 1904. No. 61388.

MECHANICAL ENGINEERING

AUTOMOBILES.

Albany.

The Albany "Silent Safety" Petrol Car. Illustrated detailed description. 2800 w. Auto Jour—Feb. 20, 1904. No. 61142 A.

Ariel.

The Ariel Petrol Cars. Illustrates and describes the characteristic features. 1200 w. Auto Jour—Feb. 27, 1904. No. 61-291 A.

Army Automobiles.

The United States Army General Utility and Repair Automobile. Illustration, with detailed description. 600 w. Sci Am Sup—March 26, 1904. No. 61724.

Belsize.

The 16-20-H. P. 3-Cylinder Belsize Car. Illustrated description of a car of English construction. 800 w. Auto Jour—March 19, 1904. No. 61758 A.

Carburation.

Carburetters and Carburation. F. Strickland. Discusses the requirements of a carburetter. 1700 w. Autocar—Feb. 20, 1904. No. 61163 A.

Commercial Vehicles.

Commercial Vehicles Practically Considered. Hiram Percy Maxim. Read before the Auto. Club of America. A discussion of the present state of the art of construction and details of cost of operation. 2000 w. Automobile—March 26, 1904. Serial. 1st part. No. 61742.

Coronet Cars.

The Coronet Cars. Illustrated description of a new English-built car. 1300 w. Autocar—March 19, 1904. No. 61754 A.

Daimler.

The 1904 Daimler Petrol Cars. Illustrated detailed description of this new design, calling attention to the noticeable changes. 1800 w. Auto Jour—March 5, 1904. No. 61401 A.

De Dion-Bouton.

The Latest De Dion-Bouton Petrol Car. An illustrated detailed description of a 10 h. p. car made by this Paris firm. 3400 w. Auto Jour—March 19, 1904. Serial. 1st part. No. 61756 A.

Engines.

The New 12 H. P. James and Browne. Illustrates and describes some of the details of the engine design. 1000 w. Autocar—Feb. 27, 1904. No. 61289 A.

Exhibition.

The Crystal Palace Exhibition. An illustrated article calling attention to novel features in the exhibits, and describing interesting vehicles. 9800 w. Auto Jour—Feb. 27, 1904. No. 61290 A.

The Crystal Palace Exhibition. Illustrations, with descriptions of interesting exhibits. 6000 w. Auto Jour—Feb. 20, 1904. No. 61140 A.

The International Automobile Exposition at Paris. Lucien Perissé. A general account of the exposition of December, 1903, with illustrated description of the leading mechanical features and special types exhibited. 4500 w. Engineering Magazine—April, 1904. No. 61687 B.

French Trials.

French Fuel Consumption and Reliability Trials. Report of these trials, giving tabulated results and illustrations. 1500 w. Auto Jour—March 12, 1904. No. 61488 A.

Gardner-Serpollet.

The 1904 Gardner-Serpollet Cars. Illustrates and describes the 9 h. p. car called the "Simplex," remarkable for its simple construction, economy in fuel, and ease with which it may be driven. 900 w. Autocar—March 12, 1904. No. 61483 A.

Gobron-Brillie.

The 25 h. p. Gobron-Brillie Petrol Car (1904 Type). Illustrated detailed description. 1000 w. Auto Jour—March 12, 1904. No. 61485 A.

Ignition.

An Improved High Tension Ignition. Illustrates and describes an invention, making use of a discovery by Sir Oliver Lodge, which makes the ignition much less sensitive to external or internal causes of derangement. 600 w. Autocar—March 12, 1904. No. 61484 A.

Lubrication.

Gasoline Engine Lubrication. A. E. Potter. Causes of heating and sticking and of excessive oil in cylinders are considered; also best forms of design and proper qualities and quantities of oil. 1700 w. Automobile—March 26, 1904. No. 61743.

Mercedes.

The 1904 Mercedes Models. Illustrations with descriptions of two new cars. 800 w. Auto Jour—Feb. 20, 1904. No. 61141 A.

Motor Bicycles.

Desirable Improvements on Motor Bicycles. Merwyn O'Gorman. From a paper read before the Auto. Club of Gt. Britain & Ireland. Suggestions for increasing speed, fuel efficiency, noiselessness, &c., are discussed. 2000 w. Automobile—March 12, 1904. Serial. 1st part. No. 61390.

Motor Wagon.

A Turbo-Electric Wagon. Illustrated description of a novel design propelled by means of a steam turbine and electric motors. 1300 w. Mech Engr—Feb. 20, 1904. No. 61138 A.

Pedrail.

A Walking Locomotive. Illustrations of the pedrail, with description as given by Prof. Hele-Shaw, and remarks. 1800 w. U S Cons Rept—March, 1904. No. 61514 D.

Racing.

How to Tune Up a Racing Automobile. Joseph Tracy. Gives practical suggestions for the guidance of entrants in races who drive medium or high-powered cars. 2500 w. Automobile—March 5, 1904. Serial. 1st part. No. 61321.

Ryknield.

The Ryknield Petrol Cars. English cars which show new features are illustrated and described. 2000 w. Auto Jour—March 5, 1904. No. 61402 A.

Talbot Cars.

The Talbot Petrol Vehicles. Illustrates their 8 h. p. standard tonneau, and the engines on the 20 h. p., the 11 h. p., and the 8 h. p. vehicles, with remarks. 700 w. Auto Jour—March 19, 1904. No. 61757 A.

Thornycroft.

The 20 h. p. Thornycroft Petrol Car (1904 Model). Explains the alterations that have been made, giving an illustrated description of one of the latest cars. 1300 w. Auto Jour—March 5, 1904. No. 61403 A.

Tires.

Motor Car Tires and Springs. J. S. V. Bickford. Discusses the weaknesses of these parts, favoring solid tires, and double elliptical springs, suitably proportioned to the load. Ill. 2500 w. Engr, Lond—Feb. 26, 1904. No. 61314 A.

Tyre Manipulation Illustrated. A series of illustrations showing the most approved methods of detaching and replacing a pneumatic tyre. 500 w. Autocar—March 19, 1904. No. 61755 A.

Trials.

The Progress of Automobilism in 1903 (Les Progrès de l'Automobilisme en 1903). F. Drouin. A review of the principal trials and races of the year. Two articles. 3000 w. Génie Civil—Feb. 13, 20, 1904. No. 61621 each D.

HEATING AND COOLING.

Central System.

Heating from a Central Station. W. H. Pearce. An illustrated article showing that with proper appliances and experience, heating from a central station is a success, and pointing out the cause of loss in the various methods. Also discussion. 14400 w. Jour W Soc of Engrs—Feb., 1904. No. 61542 D.

Central Station Heating. W. H. Schott. Read before the Northeastern Elec. Assn. Discusses when hot-water systems may be used, and when steam would serve better, and the requirements and how to meet them. Shows the importance of automatic regulation. 3000 w. Dom Engng—Feb. 25, 1904. No. 61101 C.

Heat Losses.

To Figure Heating Work Accurately. With a Table Showing the Losses in British Thermal Units for Various Surfaces. Charles F. Hauss. Read at N. Y. meeting of the Am. Soc. of Heat. & Ven. Engrs. Explains the use of the table given. 1000 w. Dom Engng—Feb. 25, 1904. No. 61102 C.

Refrigeration.

A Modern Closed Type Ice Making Plant. Illustrated detailed description of the Peoples Pure Ice Co.'s plant, Chicago, for distilled-water ice manufacturing. 3500 w. Ice & Refrig—March, 1904. No. 61-272 C.

Theatre.

The Cooling Plant of the New Municipal Theatre at Cologne (Die Luftkühlanlage für das Neue Stadttheater in Köln a. Rh.). Joseph Musmacher. A full account of the plant for supplying artificially cooled air in summer time. The temperature of the theatre is maintained at 20° C. 3000 w. 1 plate. Gesundheits-Ingenieur—March 10, 1904. No. 61669 D.

Ventilating and Heating the Franklin Square Theatre, Worcester, Mass. Gives plan and description of an interesting plant, having features that are somewhat unusual. 1200 w. Eng Rec—March 26, 1904. No. 61738.

HYDRAULICS.

Elevators.

The Elevators of the Central London Railway (Ascenseurs du Central London Railway). Illustrated description of the hydraulic lifts at the Shepherd's Bush station. 2000 w. 1 plate. Génie Civil—Feb. 20, 1904. No. 61623 D.

Jets.

The Contraction of Jets. Prof. John Goodman. Gives results of an investigation made to obtain a rational coefficient of contraction for a jet issuing from a plain circular orifice. 1200 w. Engng—March 11, 1904. No. 61508 A.

Pumping.

Pumping Machinery for the New Dock at Chatham. Gives illustrations showing the general arrangements of the plant, which is provided with both centrifugal and suction pumps. These are described in detail. 1200 w. Engng—Feb. 26, 1904. No. 61309 A.

Pumping Engine.

Compound Cornish Cycle Pumping Engine. Illustrated description of a very large pumping-engine at the Waihi Mines, in New Zealand. 1000 w. Engng—March 18, 1904. No. 61770 A.

See Civil Engineering, Water Supply.

Safety Devices.

Safety Devices for Hydraulic Plants. Frank B. Kleinhans. Describes devices to prevent breakages of pipes and cylinders, and other injuries. 1100 w. Eng News—March 3, 1904. No. 61228.

INTERNAL-COMBUSTION MOTORS.

Blowing Engine.

Gas-Driven Blowing Engine with Sliding Air-Valves. Two-page plate, with brief description. 300 w. Engng—March 4, 1904. No. 61414 A.

Fuel Gas.

A Process for the Conversion of Fuels into Heating and Power Gas (Ein Verfahren zur Umsetzung der Brennstoffe in Heiz oder Kraftgas). H. Jahns. Describing a form of series gas producer at the Von der Heydt mines near Saarbruck. 2500 w. Zeitschr d Ver Deutscher Ing—Feb. 27, 1904. No. 61611 D.

Furnace Gas.

The Blast Furnace as the Sole Source of Power in a Modern Steel Works. Abstract of an article by Carl Gruber, translated from *Stahl und Eisen.* Describes an imaginary plant. 2800 w. Ir Age—March 17, 1904. No. 61431.

The Purification of Furnace and Producer Gas (Die Gicht und Generatorgas Reinigung). E. Theisen. A description of a form of centrifugal apparatus for removing dust and grit from furnace gases used in gas engines. 3500 w. Stahl u Eisen—March 1, 1904. No. 61672 D.

Gas Engines.

Some Notes on Gas Engines. H. Diederichs. Discusses interesting tests and treatises that have appeared in recent German literature, giving also facts from the writer's own observations. 3000 w. Sib Jour of Engng—Feb., 1904. No. 61187 C.

Gasoline Motor.

The Tygard Reciprocating-Cylinder Double-Action Gasoline Motor. Illustrated description of a motor exhibited at the recent automobile show. 1000 w. Sci Am—March 12, 1904. No. 61370.

Gas Pumping Engines.

See Civil Engineering, Water Supply.

Marine Motors.

Petrol Motors for Marine Purposes. Remarks on the growing use of these motors, the leading forms, and reliability, with information from a paper by Orlando Sumner before the Inst. of Marine Engrs. (England). 1500 w. Engng—Feb. 26, 1904. No. 61311 A.

The Mietz & Weiss Two-Cylinder Marine Kerosene Engine. Illustrated detailed description. 1400 w. Am Ship—March 24, 1904. No. 61595.

Petrol Engine.

A Peculiar Petrol Engine—The "Daniel." Brief illustrated description of an engine in which elliptical cams replace the cranks on the main shaft, and in which no connecting rods are employed. 1100 w. Auto Jour—March 12, 1904. No. 61486 A.

Valves.

Valves and Valve Mechanism of Internal Combustion Engines. Robert E. Phillips. Excerpt from a paper read at the Auto. Club. Considers only engines of the "Otto" or four-cycle type. Ills. 4000 w. Auto Jour—March 12, 1904. No. 61487 A.

See also Mechanical Engineering, Automobiles.

MACHINE WORKS AND FOUNDRIES.

Boiler Making.

The "Fatal Blue Heat" in Boiler Making. From *Motive Power.* Explains the meaning of this term by experiment, and the results following the appearance. 600 w. Am Mach—March 17, 1904. No. 61427.

Boring-Machines.

Foreign and American Types of Electrically-Operated Horizontal Boring-Machines. Frank C. Perkins. Illustrated detailed descriptions. 800 w. Sci Am Sup—March 5, 1904. No. 61283.

Castings.

Casting Iron Around Steel. E. H. Powell. Gives directions for this class of work. 1100 w. Foundry—March, 1904. No. 61166.

Defects in Cast Iron, Their Causes and Remedies. Herbert E. Field. Read before the New England Found. Assn. Considers shrinkage and its causes, prevention, &c., blow holes, cracks, cold shuts, weakness, dirt, and hardness. 5700 w. Ir Trd Rev—March 17, 1904. No. 61441.

Direct-Metal and Cupola-Metal Iron Castings. Thomas D. West. Remarks on observations while handling direct metal for foundry purposes. 400 w. Trans Am Inst of Min Engrs—Feb., 1904. No. 61564.

Preparing Castings for Machine Work. Frank B. Kleinhans. Describes pickling, putting through the foundry mill, grinding, and chipping. 1500 w. Foundry—March, 1904. No. 61169.

Specifications for Cast-Iron and Finished Castings. Richard Moldenke. Remarks on the research work of foundry men and the results. 700 w. Trans Am Inst of Min Engrs—March, 1904. No. 61563.

Specifications for Pig-Iron and Iron Castings. Robert Job. Gives the method used by the Philadelphia & Reading Railway Co., with remarks. 600 w. Trans Am Inst of Min Engrs—Feb., 1904. No. 61565.

Cupolas.

Fan Power for the Cupola. Thomas D. West. Read before the Pittsburg Found. Assn. Discusses the need of a more definite basis for purchasing the necessary power to run foundry fans. Also considers blast pressure gauges, and blast volume. 3000 w. Ir Trd Rev—March 10, 1904. No. 61324.

Design.

Notes on Design. C. F. Blake. The present article considers machinery shafting 1200 w. Mach, N. Y.—March, 1904. Serial. 1st part. No. 61203 C.

Dies.

A New Die Head. Illustrated detailed description, with details in regard to the making. 2000 w. Engr, Lond—Feb. 26, 1904. No. 61317 A.

Forging Dies. Thomas Beasley. Illustrates and describes dies for "pin ends," for "head rods," and for eye bolts. 800 w. Am Mach—March 10, 1904. No. 61328.

Electric Power.

Electric Power in Workshops. J. T. Irwin. Read before the Rugby Engng. Soc. Discusses points that should be taken into consideration in planning the equipment. 2500 w. Prac Engr—March 4, 1904. No. 61400 A.

Electric Power in British Shipyards. C. S. Vesey Brown. Begins a review of electric power installations, with special reference to the north-east coast, illustrating applications made and the machines. The first of two articles. 3300 w. Cassier's Mag—March, 1904. No. 61580 B.

Some Uses of Electricity in the Working of Metals. C. F. Burgess. Points out various electrical properties which have been utilized. 2000 w. Wis Engr—Feb., 1904. No. 61181 D.

Emery Wheels.

The Manufacture of Emery Wheels. Waldon Fawcett. Describes the different processes used in making emery and corundum wheels. Ills. 1200 w. Sci Am Sup—March 12, 1904. No. 61372.

Factory Buildings.

The Planning of Factory Buildings and the Influence of Design on Their Productive Capacity. Hugo Diemer. Suggestions aiming to secure utility and economy, and with a view to future expansion. 3000 w. Eng News—March 24, 1904. No. 61712.

Factory Location.

The Economic Theory of Factory Location. Hugo Diemer. Discusses the problem of factory location, and the considerations that influence it. 2000 w. Ry Age —March 18, 1904. No. 61587.

Fly-Wheels.

Drum-Head Casing for Fly-Wheels. E. E. Clock. Remarks on the power consumed in moving air, and the advantage of casing, describing how the work should be done. Ill. 800 w. Power—March, 1904. No. 61134 C.

Molding Fly-Wheels with Segments. Paul R. Ramp. Describes the manner in which the writer has successfully molded and cast many large wheels. Ills. 1200 w. Foundry—March, 1904. No. 61168.

Grate-Bars.

Making a Lot of Herring-Bone Grate-Bar Patterns. J. L. Gard. Illustrations, with brief description. 600 w. Am Mach —March 17, 1904. No. 61426.

Grinding.

Points in Shop Management. Frank B. Kleinhans. Discusses the uses of the grinding machine, the lining up of work, &c. Ills. 2200 w. Ir Trd Rev—March 3, 1904. No. 61197.

The Grinding Machine *v.* the Lathe. Gives facts and figures showing the advantages and economy of grinding machines. 3500 w. Engr, Lond—Feb. 19, 1904. No. 61154 A.

Hammers.

Pneumatic-Power Hammers. Illustrations, with descriptions of a new type motor-driven with a swing motor. Also other special arrangements. 1200 w. Engng. Feb. 19, 1904. No. 61152 A.

Recent Developments in Power Hammers. H. F. Massey. Read before the Manchester (England) Ass'n of Engrs. (Abstract.) An illustrated article describing early forms and the efforts at improvement in both spring and pneumatic hammers, with information concerning them. 4500 w. Mech Engr—March 19, 1904. No. 61760 A.

Jigs.

Set of Jigs for a Manufacturing Operation. L. O. Danse. Illustrated description of methods adopted in making the steering connection knuckle of the Cadillac automobile. 1800 w. Am Mach—March 3, 1904. No. 61207.

Lathes.

An English Design of High-Speed Lathe. Ilustrates a lathe for use with high-speed steel, and gives report of a recent test. 1000 w. Am Mach—March 10, 1904. No. 61326.

14-Inch Hydraulic Boring Lathe. Illustrated description of a heavy lathe intended for boring gun forgings, marine shafting and ingots. Built at Hamilton, Ohio. 1200 w. Engng—March 4, 1904. No. 61415 A.

Hydraulic-Feed 14-Inch Boring Lathe. Illustrated description of an interesting powerful machine. 1200 w. Mach, N Y—March, 1904. No. 61199 C.

Machine Tools.

How Machine Tools Are Developed. John Randol. A criticism of the methods of machine-tool builders. 1800 w. Am Mach—March 24, 1904. No. 61597.

Milling.

Fixtures for Milling a Sewing Machine Arm. H. Robinson. Illustrated description. 900 w. Am Mach—March 24, 1904. No. 61596.

Milling Machines.

A Milling Cutter Working on a New Principle. Illustrates and describes the cutter of the Hess machine. 900 w. Mach, N Y—March, 1904—No. 61201 C.

Screw Milling Machines. H. Liebert. Abstract of a paper read before the Manchester Ass'n. of Engrs. An illustrated article describing this machine, its working and giving information in regard to it. 3500 w. Am Mach—March 17, 1904. No. 61425.

Molding.

Some Notes on Molding Patterns for Hand Work. Walter J. May. Suggestions for the making and storing of foundry patterns. 1200 w. Prac Engr—March 11, 1904. No. 61489 A.

Weights for Holding Down. Thomas D. West. States rules that can be applied to figuring the weight necessary to hold down the cope and core of the mould. 1500 w. Foundry—March, 1904. No. 61167.

Needle Plate.

Making a Sewing Machine Needle Plate. H. Robinson. Illustrates and describes in detail the machine work. 500 w. Am Mach—March 24, 1904. No. 61598.

Punches.

Hardening and Tempering Punches. E. R. Markham. Describes methods used. 800 w. Am Mach—March 3, 1904. No. 61206.

Treatment of Punches. E. R. Markham. Suggestions for the making and use of punches, material best suited, &c. 1200 w. Am Mach—March 10, 1904. No. 61325.

Reversing.

Reversing Gear for Reciprocating Machine Tools (Kehrgetriebe für Werkzeugmaschinen mit Hin- und Hergehender Bewegung). Hermann Fischer. Describing an improved auxiliary reversing gear adapted for use with planers and similar machine tools. 2000 w. Zeitschr d Ver Deutscher Ing—Feb. 27, 1904. No. 61610 D.

Salt Mills.

The Alexandershall Salt Mills at Berka-on-the-Werra (Salzmühlenanlage der Gewerkschaft Alexandershall in Berka a/Werra). With plans of the buildings and details of the mills for grinding the potassium salts for fertilizing purposes. The machinery is driven by steam turbines. 1200 w. Zeitschr d Ver Deutscher Ing—March 5, 1904. No. 61614 D.

Shops.

Features of the Michigan Stove Company's Plant and Methods. Illustrated detailed description. 4000 w. Ir Trd Rev—March 3, 1904. No. 61196.

Works of the Smith Premier Typewriter Company, Syracuse, N. Y. Illustrated description of a new plant which is an example of modern practice in factory construction and equipment. 2800 w. Eng Rec—March 5, 1904. Serial. 1st part. No. 61240.

Surfacing.

Getting a Fine Surface in Brass Castings. C. Vickers. Outlines a method the writer has used with success. 1500 w. Am Mach—March 17, 1904. No. 61428.

Tools.

Standard Taps, Reamers and Counterbores. Jos. M. Stabel. Gives tables for fluting taps, fluted reamers, counterbores with inserted pilots, with charts and explanatory notes. 600 w. Am Mach—March 3, 1904. No. 61205.

MATERIALS OF CONSTRUCTION.

Alloys.

The Reports of the Alloys Research Committee. T. K. Rose. Aims to sum up the work of the Committee and to bring forward the portions of the researches which now appear most valuable. 2200 w. Engr, Lond—Feb. 19, 1904. Serial. 1st part. No. 61153 A.

Calcium Steel.

Calcium Steel, the New Rival of Ceramic Products. Information concerning this product, translated from *L'Echo des Mines et de la Metallurgie.* 1500 w. Sci Am Sup—March 19, 1904. No. 61437.

Cast Iron.

Notes on the Physics of Cast Iron. Richard Moldenke. A review of recent work on the physics of cast-iron showing the lines along which investigations have been made. 3000 w. Trans Am Inst of Min Engrs—Feb., 1904. No. 61561.

On Fragments of Cast Iron, Designated as Crystals. Carl Benedicks. Gives results of some investigations made. Ills. 800 w. Ir & Steel Met—March, 1904. No. 61528 D.

The Mobility of Molecules of Cast-Iron. A. E. Outerbridge, Jr. Supplementing an earlier paper. Describes investigations made which disprove the supposed fact that cast-iron under the influence of repeated shocks becomes brittle. Ills. 5500 w. Trans Am Inst of Min Engrs—Feb., 1904. No. 61555.

Chrome Steel.

Investigations of Chrome Steel (Recherches sur les Aciers au Chrome). Léon Guillet. Giving data and results of investigations into the physical and mechanical properties of chrome steels of various compositions, with microphotographs of etched surfaces. Two articles. 2500 w. Génie Civil—March 5, 12, 1904. No. 61627 each D.

Copper.

The Use of Copper in Engineering Practice. W. Ed. Storey. Abstract of a paper read before the Manchester Ass'n of Engrs. Considers the virtues and faults of copper as a material for the use of engineers. 3800 w. Mech Engr—Feb. 20, 1904. Serial. 1st part. No. 61139 A.

Hardening.

Hardening and Tempering Steel. Abstract of a paper by Prof. A. Stansfield, of McGill University, read before the Canadian Ry. Club. Ills. 1400 w. R R Gaz —March 18, 1904. No. 61457.

High-Speed Steels.

High-Speed Tool Steel—Its Manufacture and Use. J. M. Gledhill. Condensed paper, read before the Coventry Engng. Soc. Describes the method of manufacturing modern crucible steel, and considers the recent rapid progress and development of high-speed steel. 6600 w. Engr, Lond —March 11, 1904. No. 61512 A.

Manufacture and Use of High-Speed Tool Steel. J. M. Gledhill. Read before the Coventry Engng. Soc. Briefly notes the other systems of making steel, especially crucible steel, to make the recent results with high-speed tool steel better understood. 3500 w. Mech Engr—March 19, 1904. Serial. 1st part. No. 61761 A.

The Introduction of High-Speed Steels in Engineering Work-Shops. Frank Fielden. Some suggestions for the success of these improved tools. 2500 w. Engng—March 4, 1904. No. 61411 A.

Lubricants.

A New Method of Testing Lubricants (Ueber eine Neue Untersuchungs methode Flüssiger Schmiermittel). K. Wilkens. Illustrating a device consisting of a paddle-wheel in a closed chamber containing the oil, the resistance to motion of the wheel giving a measure of viscosity. 5000 w. Elektrotech Zeitschr—Feb. 18, 1904. No. 61653 B.

Lubricating Oils and Their Properties —How to Test Them and Detect Adulterations. William M. Davis. Explains how the products of crude petroleum are separated, and the means of testing. 1200 w. Power—March, 1904. No. 61133 C.

Manganese Steel.

The Researches of Guillet upon Manganese Steel (L. Guillets Untersuchungen über Manganstahl). E. Ledebur. Abstract and review of the investigations of Guillet, especially upon manganese steels of low carbon content. 2500 w. Stahl u Eisen—March 1, 1904. No. 61671 D.

Nickel Steel.

The Allotropic Transformations of Nickel Steels (Les Transformations Allotropiques des Aciers au Nickel). O. Boudouard. Tabulated results of tests of steels with 0.12 and 0.80 per cent. of carbon, and gradually increasing contents of nickel. 1200 w. Comptes Rendus—Feb. 8, 1904. No. 61652 D.

Steel Castings.

The Resistance of Steel Castings at Ordinary and Higher Temperatures (Versuche über die Festigkeitseigenschaften von Stahlguss bei Gewöhnlicher und Höherer Temperature). C. Bach. Data and results of tests, with diagrams showing the diminution of strength with increase in temperature. 1200 w. Zeitschr d Ver Deutscher-Ing—March 12, 1904. No. 61619 D.

Testing.

Commercial Tests of Material. E. G. Izod. Read before the Engng. Soc., Univ. College, London. Considers tests to determine the quality of materials for commercial purposes. 2800 w. Engng—March 11, 1904. No. 61507 A.

MEASUREMENT.

Inch-Unit.

The Inch-Unit System. Thomas Parker. Gives a comparison of the inch and centimetre, showing the advantage of the inch, and discussing the disadvantages of the metric system as applied especially to linear units, suggesting the change to the inch as a unit measure. 1200 w. Engr, Lond—March 4, 1904. No. 61421 A.

Metric System.

The Metric System: Shall It Be Compulsory? Prof. W. Le Conte Stevens. Reviews the history of the standards of measurement in use, and discusses the need of uniformity in the commerce of nations, and the steps that have been taken to that end. 5600 w. Pop Sci M—March, 1904. No. 61165 C.

Recorder.

Apparatus for Studying the Secondary Movements of Vehicles (Méthode pour l'Etude Experimentale des Mouvements Secondaires sur les Véhicules en Marche). M. Sabouret. A combination of pneumatic diaphragm devices for recording the oscillations and other secondary motions of railway and road vehicles. 1200 w. Comptes Rendus—Feb. 29, 1904. No. 61651 D.

Stresses.

The Direct Observation of the Distribution of Stresses (Ueber Unmittelbar Beobachtung der Spannungsverteilung). Otto Hönigsberg. An examination of the location of neutral lines and surfaces in bodies under stress, including optical methods of investigation. 6000 w. Zeitschr u d Oesterr Ing u Arch Ver—March 11, 1904. No. 61643 D.

Thermal Measurements.

New Autographic Method to Ascertain the Critical Points of Steel and Steel Alloys. E. Saladin. Describes the method and apparatus used, and the applications. Ills. 2500 w. Ir & Steel Met—March, 1904. No. 61527 D.

POWER AND TRANSMISSION.

Compressed Air.

Compound Compressor at the St. Pancras Mine at Nürschan (Verbund-Stufen-Kompressor der St. Pankrazzeche in Nürschan). Julius Divis. With diagrams from the steam and air cylinders, showing the action of the Riedler valve gear. 2000 w. 1 plate. Oesterr Zeitschr f Berg u Hüttenwesen—Feb. 13, 1904. No. 61649.

The Compressed Air Power Plant at the St. Louis Exposition. Illustrated description of one of the compressors. 750 w. Compressed Air—March, 1904. No. 61526.

The St. Louis Union Terminal Station. Illustrates and describes the plant for supplying compressed air, and notes the applications made. 450 w. Compressed Air—March, 1904. No. 61525.

Crane.

Steam Locomotive Crane of Three Tons Capacity (Fahr barer Dampfkran von 3000 kg. Tragfähigkeit). W. Pickersgill. With details of construction, including arrangement of friction clutches and of variable radius gear. 2000 w. Zeitschr d Ver Deutscher Ing—Feb. 20, 1904. No. 61604 D.

Elevators.

Grain Elevators (Getreidespeicher). M. Buhle. A fully illustrated account of modern warehouses and appliances for storing and handling grain, with examples from various parts of Europe and America. Three articles. 10000 w. 1 plate. Zeitschr d Ver Deutscher Ing—Feb. 13, 20, March 5, 1904. No. 61600 each D.

Gearing.

Use of Diagrams and Tables for the Solution of Problems in Gearing. Frank B. Kleinhans. Explanation, illustrated by examples. 1200 w. Mach, N Y—March, 1904. No. 61202 C.

Shaft Hangers.

The "Slot System" of Attaching Shaft Hangers and Fixtures to Concrete-Steel Structures. Henry Parsons Jones. A statement of the general conditions and illustrated discription of the work as carried out in attaching shaft hangers, stringers for counter shafts and other fixtures to a concrete-steel floor system. 2800 w. Eng News—March 3, 1904. No. 61226.

Warehouse Plant.

The Mechanical Plant of the Tietz Warehouse in Berlin (Die Technische Einrichtungen des Warenhauses Hermann Tietz in Berlin). Wilhelm Küppers. Including engines, boilers, hoisting machinery and electric plant of a large modern warehouse with numerous illustrations. 2500 w. Zeitschr de Ver Deutscher Ing—March 12, 1904. No. 61617 D.

STEAM ENGINEERING.

Accumulator.

The Rateau Steam Accumulator (Accumulateur de Vapeur Système Rateau). Ch. Dantin. Describing and illustrating devices for equalizing the pressure of exhaust steam from pumps and other high-pressure machines, enabling it to be used in steam turbines. 3500 w. 1 plate. Génie Civil—March 12, 1904. No. 61628 D.

Auxiliaries.

Steam Power Plant Auxiliaries. Horace E. Sibson. Aims to show how a properly designed feed-water heater can produce a great saving and better efficiency. 1500 w. Sib Jour of Engng—March, 1904. No. 61533 C.

Boilers.

A Study of Marine Water-Tube Boilers (Etude sur les Générateurs Marins à Tubes d'Eau). E. Duchesne. Discussing especially the circulation in boilers constructed with internal circulating tubes, giving data and results of experiments with models. 6000 w. Mem Soc Ing Civ de France—Jan., 1904. No. 61674 G.

Evaporative Test of a Babcock & Wilcox Boiler; Comparison of Closed Ash-Pit and Closed Fire-Room Systems of Forced Draft, with Notes on Water-Tube Boilers. Lieut.-Com. B. C. Bryan and Lieut. A. M. Proctor. Ills. 7600 w. Jour Am Soc of Nav Engrs—Feb., 1904. No. 61787 H.

Steam Boilers for Power Plants. W. D. Chester. Considers some of the properties and qualities of the natural elements as required for use in steam generating plants, and the relation of fire-tube and water-tube boilers to power plants. 4700 w. Pro Engrs. Soc of W Penn—Dec., 1903. No. 61541 D.

Water-Tube Boiler. Illustrated description of a new type designed by W. E. Berry, for land work, to deal with dirty feed-water. 1000 w. Engr, Lond—Feb. 26, 1904. No. 61315 A.

Boiler Furnaces.

Comparative Efficiency of Internally and Externally-Fired Boilers. D. W. Robb. Discussing a pair of closely corresponding, independently conducted tests of boilers with external oven furnace and internal corrugated furnace. 3000 w. Engineering Magazine—April, 1904. No. 61688 B.

Condenser.

The Central Condensing Plant of the Burbach Iron Works (Zentralkondensation der Burbacher Hütte in Burbach). Illustrating details of condenser, cooling tower, pumps, and general arrangement for condensing 30,000 kilogrammes of steam per hour. 2000 w. Stahl u Eisen—March 1, 1904. No. 61673 D.

Dampers.

Automatic Damper Regulators. R. T. Strohm. Illustrates and describes several types and explains their advantages. 3000 w. Am Elect'n—March, 1904. No. 61209.

Economizer.

The Green Fuel Economizer. A. H. Blackburn. Read before the Phila. Found. Ass'n. Gives the history of this invention, the advantages claimed, applications, commercial value, and description of the apparatus. 2800 w. Ir Age—March 17, 1904. No. 61430.

Engines.

A Century-Old Colliery Engine—Last Survivor of the Newcomen Type. Benjamin Taylor. Illustrated description of an engine plant at Farme Collieries installed in 1810. 2800 w. Power—March, 1904. No. 61132 C.

An Allen High-Speed Triple-Expansion Engine. Description, with diagram and test figures taken from the official trial. 1400 w. Elect'n, Lond—Feb. 26, 1904. No. 61345 A.

Feed Water.

Water Softening. James O. Handy. Considers the damage done by hard water, methods of softening, the growth and present development, the chemistry, and some municipal water softening plants. Ills. 19500 w. Pro Engrs Soc of W Penn—Dec., 1903. No. 61538 D.

Heat Diagrams.

New Diagrams for the Technical Applications of Heat (Neue Diagramme zur Technischen Wärmelehre). Dr. R. Mollier. Illustrating modifications of the temperature-entropy diagram, with practical applications. 2000 w. Zeitschr d Ver Deutscher Ing—Feb. 20, 1904. No. 61605 D.

Heat Transmission.

The Transmission of Heat in Various Parts of Boiler Heating Surface (Der Wärme übergang und seine Verschiedenheiten innerhalb einer Dampfkesselheizfläche). Paul Fuchs. With diagrams showing the results of experiments upon a water-tube boiler, showing the influence of circulation. 4000 w. Zeitschr d Ver Deutscher Ing—March 12, 1904. No. 61618 D.

Injectors.

Injector Troubles and Repairs. Fred H. Colvin. Discusses repairs, with special reference to locomotive injectors. Ills. 3000 w. Mach, N Y—March, 1904. No. 61200 C.

Oil Burners.

Oil Burners and Their Accessories. Amanda T. Jones. Begins a discussion of ways of successfully using petroleum for steam making. 1000 w. Engr, U S A—March, 1904. Serial. 1st part. No. 61215.

Powdered Coal.

Burning Powdered Coal. H. J. Travis. Illustrates and describes apparatus designed for this purpose, pointing out facts brought out in an extensive investigation of various types. 3000 w. Power—March, 1904. No. 61135 C.

Regeneration.

Steam Regeneration: Its History. H. J. Barron. Reviews the work in this field. 1200 w. Sci Am Sup—March 12, 1904. No. 61373.

Speed Regulation.

A Graphical Treatment of the Problem of Speed Regulation (Das Regulierproblem in Vorwiegend Graphischer Behandlung). Dr. A. Koob. An exhaustive graphical treatment of the forces acting in steam engines with regard to the control and regulation of speed. Serial, Part I. Zeitschr d Ver Deutscher Ing—Feb. 27, 1904. No. 61608 D.

Steam.

The Pressure of Steam Above 100° (Die Spannung des Wasserdampfes über 100°). H. F. Wiebe. An examination of Regnault's experiments, with minor corrections. 1500 w. Zeitschr d Ver Deutscher Ing—Feb. 27, 1904. No. 61612 D.

Steam Economy.

Steam Economy in the Locomotive. J. B. Allfree. A careful treatment of this subject, considering distribution of steam, the volume of cylinder clearance, mean temperature, and material and workmanship. Also general discussion. 13700 w. Pro St. Louis Ry Club—Feb. 12, 1904. No. 61174.

Steam Flow.

Notes on the Flow of Steam Through Nozzles (Beiträge zur Theorie der Dampfströmung durch Düsen). Dr. Prandtl. An examination of the theory of Prof. Lorenz, with comments by Dr. Proell. 2000 w. Zeitschr d Ver Deutscher Ing—March 5, 1904. No. 61616 D.

Steam Plant.

A Textile Mill Power Plant. Eugene B. Whipple. Considers a plant designed to take the place of one that had become overloaded by the increase in buildings and machinery. Ills. 2000 w. Jour Worcester Poly Inst—March, 1904. No. 61535 C.

Steam Ports.

The Dimensions of Steam Ports and Passages for Engines (Die Abmessungen der Steuerkanäle der Dampfmaschinen). M. F. Gutermuth. An examination of the influence of the point of cut-off upon the proportions of steam passages. 3500 w. Zeitschr d Ver Deutscher Ing—March 5, 1904. No. 61613 D.

Steam Turbines.

Efficiency Test of 1250-Kilowatt Steam Turbine for Interborough Rapid Transit Company, New York City. A. M. Mattice. Gives results of a series of performance tests conducted at the builder's works upon the first of the three units selected for the illumination of the New York subway. 3000 w. Power—March, 1904. No. 61131 C.

Methods and Results of Shop-Testing of Steam Turbines. J. R. Bibbins. Describes the tests made by the Westinghouse Machine Co. Ills. 2500 w. Eng News—March 3, 1904. No. 61227.

Phenomena of Flow in the Nozzles of Steam Turbines (Die Strömungserscheinungen in den Düsen der Dampfturbinen). Dr. A. Koob. An examination of pressures and velocities in nozzles of various forms for use in steam turbines. 2500 w. Zeitschr d Ver Deutscher Ing—Feb. 20, 1904. No. 61606 D.

Some Notes on the Steam Turbine. Homer M. Jaquays. Aims to give information concerning types and their operation, in such a form that comparisons may be made. Ills. 4000 w. Canadian Soc of Civ Engrs, Adv Proof—Feb., 1904. No. 61160 D.

Steam Turbine of 11,000 Horse-Power. Illustration, with description of turbines under construction for the power station of the Pennsylvania Railroad tunnel from Jersey City to Long Island. 900 w. Sci Am—March 19, 1904. No. 61435.

Steam Turbines, with a Special Reference to Their Adaptability to the Propulsion of Ships. Ernest N. Janson. Ills. 12500 w. Jour Am Soc of Nav Engrs—Feb, 1904. No. 61788 H.

The De Laval Steam Turbine. T. C. Porte. Abstract of a paper read before the Dublin Loc. Soc. of the Inst. of Elec. Engrs. Illustrates and describes the principle on which this turbine is founded, reporting its efficiency. 2500 w. Elect'n, Lond—March 4, 1904. No. 61424 A.

The Riedler-Stumpf Steam Turbine. Walter Rappaport. Briefly notes the different methods for utilizing the heat energy of steam, explaining the principle of the type named. Ills. 1300 w. Elec Rev, Lond—March 4, 1904. No. 61405 A.

The Terry Steam Turbine. Illustrated description of a new form of steam turbine, which resembles in a measure the Pelton water wheel. 2000 w. Ir Age—March 17, 1904. No. 61429.

See also Mechanical Engineering, Automobiles.

Stokers.

Some Performance of Boilers and Chain Grate Stokers with Suggestions for Improvement. A. Bement. Gives the performance of a Babcock & Wilcox, two Heine and one improved Heine boiler as shown in tests; considers the tile-roof furnace, and discusses the characteristics of the chain-grate stoker. General discussion. 14200 w. Jour W Soc of Engrs—Feb., 1904. No. 61545 D.

Superheating.

Superheated Steam. G. D. Seaton. Abstract of a paper read before the Staffordshire Iron & Steel Inst. Facts from the writer's experience showing the saving in cost effected by using superheaters. 1200 w. Ir & Coal Trds Rev—Feb. 26, 1904. No. 61304 A.

Turbines and Superheated Steam. W. H. Booth. Discusses the use of superheated steam in the turbine, its advantages, its steam leak losses, &c. 1600 w. Elec Rev, Lond—Feb. 26, 1904. No. 61301 A.

Test.

Test of a Steam Plant (Untersuchung einer Dampfanlage). K. Vogel. Data and results of test of Steinmuller boiler and Lentz steam engine at the works of Siemens & Halske in Berlin. 1200 w. Zeitschr d Ver Deutscher Ing—Feb. 13, 1904. No. 61601 D.

The Equipment of an Engine Test House. R. K. Morcom. Read before the Birmingham Loc. Sec. of the Inst. of Elec. Engrs. Gives a brief account of the evolution of a plant for testing combined sets for electricity stations, and of some of the results obtained. Also discussion. 6300 w. Elect'n, Lond—March 4, 1904. No. 61406 A.

Valves.

Setting Inside Admission Piston Valves. Ira A. Moore. Gives directions. Ills. 1600 w. Loc Engng—March, 1904. No. 61273 C.

Valve Gears. C. C. Major. Discusses the relation between piston and valve position and crank and eccentric angles. Ill. 1500 w. Am Elect'n—March, 1904. No. 61212.

MISCELLANY.

Aeronautics.

Aerial Navigation. O. Chanute. Read before the Am. Ass'n for the Adv. of Science. A review of the present status of the question, the prospects of its solution, and the probable uses of the hoped-for air-ships. 4300 w. Pop Sci M—March, 1904. No. 61164 C.

M. Archdeacon's Aeroplane. Illustrations of this machine with brief description. 1000 w. Auto Jour—Feb. 27, 1904. No. 61292 A.

Packing.

Note on the Packing of Machinery for Export. Paul Roux. Contributed to the American Chamber of Commerce, Paris. Directions for the preservation of the machines up to the time of delivery. 3000 w. Engng—Feb. 26, 1904. No. 61312 A.

MINING AND METALLURGY

COAL AND COKE.

Breaker.

A Bituminous-Coal Breaker. Lewis Stockett. Illustrates and describes the building and machinery erected at Stockett, Mont., giving results obtained. 1800 w. Trans Am Inst of Min Engrs—Feb., 1904. No. 61559.

Briquettes.

Fuel and Mineral Briquetting. Robert Schorr. Information concerning the manufacture of coal and coke, peat, and mineral briquettes, and artificial stone, with costs, &c. 6600 w. Trans Am Inst of Min Engrs—Feb., 1904. No. 61553 C.

British Columbia.

The Coalfields of Crow's Nest Pass, British Columbia. E. Jacobs. A fully illustrated account of the district, describing its geology together with the equipment, methods, and importance of the mines. 4000 w. Engineering Magazine—April, 1904. No. 61685 B.

Coal Industry.

See Industrial Economy.

Coal Washing.

The Coal Washer at Howe, Indian Territory. W. R. Crane. An illustrated description of the plant and of the methods of mining and handling the coal. 3500 w. Mines & Min—March, 1904. No. 61252 C.

Coke Ovens.

The Development of the By-Product Coke Oven. Curtis C. Myers. Aims to give a general idea of the coke industry at present, and a brief outline of what it may be reasonable to expect in the future with the development and more general adoption of the by-product or retort coke oven. 4000 w. Sib Jour of Engng—March, 1904. No. 61532 C.

Coke Plant.

By-Product Coke Plant. Dr. W. B. Rothberg. An illustrated general description of the installment of 232 Otto-Hoffman ovens at Lebanon, Penn., by the Lackawanna Iron & Steel Co. 1700 w. Mines & Min—March, 1904. No. 61251 C.

Collieries.

The Mechanical Equipment of Collieries. George H. Winstanley. Abstract of an address before the Manchester Geological and Mining Society. Briefly considers various applications made in modern collieries. 4000 w. Col Guard—Feb. 26, 1904. No. 61303 A.

Colorado.

The Coal Fields of Colorado. Describes the geology and the six important fields. Maps. 5600 w. Bul Colo Sch of Mines—Jan., 1904. No. 61778 D.

Costs.

Estimated Costs of Mining and Coking and Relative Commercial Returns from Operating in the Connellsville and Walston-Reynoldsville Districts, Pennsylvania. Eduard V. D'Invilliers. 4500 w. Trans

Am Inst of Min Engrs—Feb., 1904. No. 61556.

Handling.

Coal and Coke Handling. Alfred Ernst. Illustrated description of the improved machinery for stamping and charging the coal in the coke plant of the Lackawanna Iron & Steel Co., at Lebanon, Penn. 2200 w. Mines & Min—March, 1904. No. 61250 C.

Japan.

Japanese Coal Mines. K. Gonekra. A brief illustrated outline of the mining department of the Kokkaido Colliery & Railway Company, Japan. 5000 w. Mines & Min—March, 1904. Serial. 1st part. No. 61248 C.

COPPER.

Converters.

Bessemer Copper Converters. C. H. Glasser. Refers to the trough or barrel type of converter, discussing its advantages and disadvantages, stating the objections to the hydraulic systems that have developed in actual practice, and presenting supposed advantages by substituting the electric for the hydraulic equipment. 3500 w. Eng & Min Jour—March 17, 1904. No. 61444.

Electrolysis.

Note on the Relation Between Arsenic and Electro-Motive Force in Copper-Electrolysis. L. Webster Wickes. Summary of experimental investigations. 1200 w. Trans Am Inst of Min Engrs—Feb., 1904. No. 61566.

Extraction.

Wet Methods of Extracting Copper at Rio Tinto, Spain. Charles H. Jones. Describes the methods of leaching and precipitation now used at Rio Tinto. Ills. 2700 w. Trans Am Inst of Min Engrs—Feb., 1904. No. 61571.

The Payne-Gillies Copper Process. F. Danvers Power. Describes this process which is suitable for the extraction of copper from poor ores which are too silicious for smelting purposes and which cannot be concentrated mechanically at a profit. 1200 w. Eng & Min Jour—March 3, 1904. No. 61218.

GOLD AND SILVER.

Assaying.

A System of Fusing Ores for Assaying. Arthur Lachman. Abstract from the *California Jour. Tech.* Gives the writer's scheme for calculating in advance the best flux for any given ore. 2000 w. Min & Sci Pr—March 5, 1904. No. 61376.

British Columbia.

Hydraulic Mining in Cariboo, B. C. From the annual report submitted by J. B. Hobson, showing details of large operations in progress in Cariboo. 1200 w. Min & Sci Pr—Feb. 20, 1904. Serial. 1st part. No. 61113.

California.

Gold Mining in Trinity County. E. H. Nutter. A record of production dating back a half-century. Ills. 2500 w. Pacific C Min—Feb. 27, 1904. No. 61281.

Cyaniding.

Cyaniding in the Southern States. Ernest Gayford. An interesting account of recent work at the Howie mine in North Carolina. 1600 w. Min & Sci Pr—Feb. 27, 1904. No. 61266.

Notes Upon Preliminary Tests and Cyanide-Treatment of Silver Ores in Mexico by the MacArthur Forrest Process. John F. Allan. Gives practical hints on preliminary tests and calls attention to a possible enlarged field for the cyanide process in the treatment of some silver ores. 7200 w. Trans Am Inst of Min Engrs—Feb., 1904. No. 61569 C.

The Hendryx Electro-Cyanide Process. C. M. Fassett. Describes this process, stating its claims, and reporting its success. 1200 w. Min & Sci Pr—Feb. 27, 1904. No. 61265.

Dredging.

Gold Dredging Under Difficult Conditions. F. Winter Taylor. Discusses the design of a dredge that is to be worked under exceptionally hard conditions. Gives plan. 2500 w. Eng & Min Jour—March 24, 1904. No. 61701.

Native Gold.

Original Native Gold in Igneous Rocks. Walter Harvey Weed. Calls attention to several significant occurrences of gold in igneous rocks. 2000 w. Eng & Min Jour—March 17, 1904. No. 61445.

New Zealand.

Gold and Coal in New Zealand. Editorial review of the interesting Government returns for the last year. Gold constitutes 60½ per cent., and coal 23 per cent. of the mineral production. 2000 w. Engng—Feb. 26, 1904. No. 61310 A.

Queensland.

The Occurrence of Gold in Association with Antimony in Queensland. B. Dunstan. Information from the Survey Reports issued by the Mines Department. 1600 w. Queens Gov Min Jour—Jan. 15, 1904. No. 61161 B.

Slimes.

A Proposed Filter-Press Slimes Plant. Francis L. Bosqui. Report on the filter-press treatment of slimes at the Liberty Bell mine, Telluride, Colo. 4000 w.

Trans Am Inst of Min Engrs—Oct, 1903. No. 61568.

The Slime Problem. T. Lane Carter. States the advantages of a slime plant and considers recent installations on the Rand. 2000 w. Eng & Min Jour—March 17, 1904. No. 61443.

Smelting.

The Electric Smelting of Complex Sulphides. A. A. Beadle. A brief description of the more important electrometallurgical methods of treatment of lead, zinc, silver ores. 2000 w. Eng & Min Jour—March 24, 1904. No. 61703.

Tailings.

Tailings Elevators. W. H. Wood and E. J. Laschinger. Abstracted from the Jour. of the Mech. Engrs. Assn. of the Witwatersrand. Treats of appliances, made necessary by the flat nature of the ground, under the subjects of tailings wheels, tailings pumps, bucket belt elevators, and air-lift pumps. Ills. 2700 w. Eng & Min Jour—March 24, 1904. No. 61704.

IRON AND STEEL.

Basic Process.

Basic Open-Hearth Steel Castings. L. L. Knox. Read before the Pittsburg Found. Assn. Claiming that basic open-hearth steel gives castings equally as good as acid open-hearth steel, giving a description of the process in an open-hearth furnace using producer gas. 2500 w. Foundry—March, 1904. No. 61170.

Blast Furnaces.

A Decade in American Blast Furnace Practice. F. Louis Grammer. Discusses briefly the tendencies in the methods of administration as well as the conditions governing supremacy as affecting the aims of the manager, and considers the advances made during the last ten years. 6500 w. Trans Am Inst of Min Engrs—Feb., 1904. No. 61570.

Notes on the Behavior of Zinc in the Blast Furnace. John J. Porter. Deals with ores containing zinc, describing the reactions of zinc in the blast furnace, and the influence of the zinc upon the working of the furnace. 3000 w. Ir Age—March 24, 1904. No. 61575.

Stock Distribution and Its Relation to the Life of a Blast-Furnace Lining. David Baker. The results of mechanical charging are discussed and compared with the hand-barrow system, and an illustrated report of the writer's experience. 2200 w. Eng News—March 24, 1904. No. 61713.

Briquetting.

The Briquetting of Iron Ores. (Ueber Brikettierung von Eisenerzen) Dr. Alois Weiskopf. A discussion of the various binding materials employed, together with a list of patents and brief bibliography of the subject. 4000 w. Stahl u Eisen—March 1, 1904. No. 61670 D.

Electric Smelting.

See Electrical Engineering. Electrochemistry.

Heating Pits.

Doors for Heating Pits. T. H. Lauder. Read before the West of Scotland Ir. and Steel Inst. Illustrates and describes a new type of door and appliances for handling doors of large dimensions. 1500 w. Ir & Coal Trds Rev—March 4, 1904. No. 61423 A.

Ore Supplies.

The World's Iron Ore Supplies. Bennett H. Brough. Abstract of lecture and discussion. 4400 w. Pamphlet—Jour of West of Scotland Iron & Steel Inst. No. 61515 A.

Philippines.

Iron Making in the Philippines. Extract from the report of H. D. McCaskey. Gives an illustrated description of a primitive blast-furnace in the Angat iron region, Bulacan, with information concerning the industry. 6000 w. Ir Age—March 3, 1904. No. 61159.

Rolling Mills.

The Small Mill Plant vs. the Large Mill Plant. D. F. Nisbet. Examines some of the usages as to their values and efficiencies, as found in types of rolling mills taken as examples. A comparison of old and modern practice. 5500 w. Ir Trd Rev—Feb. 25, 1904. No. 61104.

Specifications.

The Standardization of Specifications for Iron and Steel. Recent Progress in America and England. William R. Webster and Edgar Marburg. Outlines the history of the movement to secure uniformity on the part of technical societies in the United Societies, and gives a brief review of the present situation in England. 1800 w. Trans Am Inst of Min Engrs—March, 1904 No. 61560.

Vermilion.

Methods of Mining in the Vermilion Iron District of Minnesota. Kirby Thomas. Illustrates and describes the working of these mines as examples of the best art in mining. 1600 w. Min & Sci Pr—Feb. 20, 1904. No. 61114.

MINING.

Ankylostomiasis.

Ankylostomiasis: A Forewarning. Walter C. C. Pakes. An interesting paper on this disease, which especially attacks miners, with discussion. 7500 w. Jour of

Chem. Met, & Min Soc of S. Africa—Jan., 1904. No. 61501 E.

Arizona.

A Trip Through Arizona. Prof. Arthur Lakes. Illustrates and describes interesting desert scenery showing the relation it bears to the geology and the mining interests of the region. 3500 w. Mines & Min—March, 1904. No. 61249 C.

Battery Frames.

A Cantilever Battery Frame. Ira C. Boss. Drawing and description of this design, with information concerning it. 1300 w. Eng & Min. Jour—March 10, 1904. No. 61359.

China.

Mining Regulations for the Jehol Region, China. A portion of the regulations covering mining in this district as suggestive of conditions in China. 1000 w. Eng & Min Jour—March 17, 1904. No. 61442.

Electric Power.

Electric Haulage in Metal Mines. General remarks, with an illustrated description of the haulage system used by the United Gold Mines Co., of Victor, Colo. 1500 w. Bul Colo Sch of Mines—Jan., 1904. No. 61780 D.

Electric Mine Locomotives. William L. Affelder. Read before the W. Penn. Cent. Min. Inst. An illustrated article considering traction, third-rail, and sprocket locomotives, their development, and the conditions to which they are adapted. 8000 w. Mines & Min—March, 1904. No. 61254 C.

Electric Winding Machines. Maurice Georgi. Abstract of a paper read before the Glasgow Local Sec. of the Inst. of Elec. Engrs. Discusses the advantages and disadvantages of electric winding, and gives an illustrated description of Mr. Ilgner's system of compensation. 2200 w. Elect'n, Lond—March 18, 1904. No. 61766 A.

Polyphase Hauling Plant at Bolsover Colliery. Illustrated description of recently installed plant. 800 w. Col Guard—March 4, 1904. No. 61409 A.

Rules for the Installation and Use of Electricity in Mines. Gives rules drawn up by the Departmental Committee. 8000 w. Elect'n, Lond—Feb. 19, 1904. No. 61146 A.

Rules of the Electricity in Mines Committee—An Analysis and a Criticism. E. Kilburn Scott. 2000 w. Ir & Coal Trds Rev—Feb. 12, 1904. Serial. 1st part. No. 61148 A.

The Electrical Mining Installations of the Hélios Electrical Company. Emile Guarini. Gives an account of the work of this company, and illustrated descriptions of installations made. 4000 w. Elec Rev, N. Y—March 12, 1904. No. 61383.

Geological Phenomena.

A Sketch of the Geology and Economics Along the Union Pacific Railway from Cheyenne to Ogden. A. Lakes. A brief popular account of what may be seen generally from the car windows along this route. Ills. 1500 w. Min Rept—March 10, 1904. No. 61384.

Korea.

Mining and Business Interests in Korea. S. Herbert Williams. Information concerning the minerals found and methods of mining; also the other industries and products. Ills. 1800 w. Eng & Min Jour—March 3, 1904. No. 61216.

Laboratory Work.

Laboratory Work Under Smelting Conditions. K. Friedrich. A short description of the construction of a small gas-heated reverberatory furnace, giving a report of its efficiency and application. Ills. 1800 w. Eng & Min Jour—March 24, 1904. No. 61702.

Metal Mines.

Gases in Metalliferous Mines. Harry A. Lee. Read before the Colorado Sci. Soc. Describes conditions as found at the Happy Thought mine, near Crude, Colo. 3000 w. Min Rept—March 3, 1904. No. 61269.

The Economic Ratio of Treatment Capacity to Ore Reserves. H. C. Hoover. Discusses mine development with the view of securing the maximum profit. 2400 w. Eng & Min Jour—March 24, 1904. No. 61700.

Mill Water.

Economy in Mill Water. Jesse Scobey. Read before the Colorado Sci. Soc. An illustrated article reviewing a plant at Washington, Arizona, where a saving of 97 per cent. of the water in circulation was made. 3000 w. Min Rept—Feb. 25, 1904. No. 61103 C.

Mining Methods.

Methods of Mining and Timbering in Large Ore Bodies in British Columbia and Michigan. Norman W. Parlee. Describes and discusses methods and their modifications as carried out in mines where the writer has worked. Ills. 7500 w. Can Soc of Civ Engrs, Adv. Proof—Feb. 25, 1904. No. 61191 D.

Ore Carriers.

Schists and Slates as Ore Carriers. Arthur Lakes. An illustrated article giving information from the writer's experiences in Colorado, Wyoming, Nevada, Arizona and North Carolina. 2000 w. Min & Sci Pr—March 5, 1904. No. 61375.

Ore Deposits.

A Peculiar Ore Deposit. E. A. Colburn. Illustrates and describes an ore shoot in Ajax mine, Cripple Creek, Colo. 800 w. Min & Sci Pr—March 19, 1904. No. 61747.

Ore in Anticlinals, as at Bendigo, Australia, and Tombstone, Arizona. Arthur Lakes. Illustrates and describes the geology of ore deposits in anticlinals. 1400 w. Min & Sci Pr—March 19, 1904. No. 61745.

The Genesis and Character of Ore Deposits. W. H. Storms. On the various forms of ore deposit, and the importance to miners of a knowledge of their occurrence. 2000 w. Min & Sci Pr—March 10, 1904. No. 61746.

Ore-Formation.

Osmosis as a Factor in Ore-Formation. Halbert Powers Gillette. Aims to show that "osmosis" supplemented by convection-currents have been the principal agencies that have gathered the scattered particles of rare minerals into the larger masses called ore. 1600 w. Trans Am Inst of Min Engrs—Oct., 1904. No. 61567.

Prospecting.

The Theory of Ore Deposits Applied to Prospecting. E. B. Wilson. Gives illustrations of manner of ore formation from crystallization of solutions. 2500 w. Mines & Min—March, 1904. Serial. 1st part. No. 61255 C.

Re-grinding.

Notes on Some Re-grinding Machines. Martin Schwerin. Gives results of a series of tests on four types of re-grinding machines, with observations on this feature of ore dressing. 2800 w. Eng & Min Jour—March 10, 1904. No. 61358.

Santiago.

Mineral Deposits of Santiago, Cuba. Harrison Sonder. A sketch of the principal mineral deposits near this place. Ills. 2500 w. Trans Am Inst of Min Engrs—Feb., 1904. No. 61554.

Shaft Sets.

The Framing of Rectangular Shaft Sets. Wilbur E. Sanders. Illustrates and describes the methods of framing almost universally accepted as affording the greatest possible strength. 2000 w. Eng & Min Jour—March 10, 1904. No. 61357.

Shaft Sinking.

Note on the Cost and Speed of Sinking the East Shaft of the New Kleinfontein Co., Benoni, South Africa. Edward J. Way. Tabulated data. 300 w. Trans Am Inst of Min Engrs—Feb., 1904. No. 61562.

Shaft Sinking Through Water-Bearing Permian, Triassic and Cretaceous Strata. Considers the methods used in sinking shafts through the more consolidated secondary rocks, which are generally very water-bearing. Ills. 4300 w. Col Guard—March 4, 1904. No. 61408 A.

Witwatersrand.

Observations on the Metallurgical Practice of the Witwatersrand. Harry S. Denny's paper is discussed at length by Wager Bradford. 4400 w. Jour of Chem, Met & Min Soc of S. Africa—Jan, 1904. No. 61502 E.

Winding.

Endless Chain Winding and Vertical Shafts. Illustrated description of method devised by Prof. O. C. von Verbo of replacing rope and cage winding, by an endless chain of links, on to which the pit tubs are hooked at certain intervals. 700 w. Col Guard—March 11, 1904. No. 61503 A.

Wyoming.

Leading Mines of Wyoming. An illustrated article reviewing briefly the principal mining camps. 2500 w. Pacific C Min—Feb. 27, 1904. No. 61280.

MISCELLANY.

Alumina.

A Method for the Direct Determination of Alumina. Charles E. Rueger. Gives comments on methods in general use and recent facts concerning their accuracy, and describes method used by the writer and the results. 2200 w. Eng & Min Jour—March 3, 1904. No. 61217.

Fireclay.

Fireclay. A study of the clays of Clinton County, Pa., explaining what constitutes fireclay, and how it is deposited. 2000 w. Mines & Min—March, 1904. No. 61253 C.

Manganese.

Some Manganese Deposits in the Gingin, Degilbo, and Warwick Districts. Lionel C. Ball. Reports of these districts, as a part of a scheme to have all manganese deposits inspected and reported. Map. 3800 w. Queens Gov Min Jour—Jan. 15, 1904. No. 61162 B.

Spain.

Some Chemical and Metallurgical Industries in Spain. Notes on the sulphate of ammonia industry, sulphate of copper, dynamite, vitriol, sulphur, alkalies, arsenic, tartaric acid, &c. 2000 w. Engng—March 18, 1904. No. 61767 A.

Tin.

Some Notes Concerning Tin. John W. Gray. Concerning the location of tin deposits, methods of extraction, the distribution and production of the metal. 2000 w. Min & Sci Pr—March 19, 1904. No. 61748.

RAILWAY ENGINEERING

CONDUCTING TRANSPORTATION.

Accident.

Train Accidents in the Quarter Ending Sept. 30, 1903. Information of interest from the last bulletin of the Interstate Commerce Commission. 1200 words. Eng News—March 3, 1904. No. 61222.

Freights.

I. The Best Way to Keep Freights on Time, from a Conductor's Standpoint. T. H. Beacom. II. How to Keep Way Freights on Time, from an Agent's Standpoint. R. F. Weeks. Two papers discussed together. Also III. The Best Way to Handle Freights so That They Will Be on Time, from Train Dispatcher's Position. 9500 w. Pro Iowa Ry Club—Jan. 19, 1904. No. 61175.

Organization.

Some Thoughts and Suggestions on Railroad Organization and Management. A. M. Waitt. Considers some of the features of organization in England, comparing with America, and discusses the needs of large systems, offering suggestions. 4000 w. R R Gaz—March 11, 1904. No. 61361.

MOTIVE POWER AND EQUIPMENT.

Air Brakes.

A Storage Air Brake System Adopted at St. Louis. An illustrated description of this installation. 2400 w. Compressed Air —March, 1904. No. 61524.

New York Air Brake Co.'s Compensating Valve for High Speed Brakes. Illustrated description of a "compensating valve" recently designed by the New York Air Brake Co., to be used in high speed brake service. 600 w. Loc Engng —March, 1904. No. 61275 C.

Axle Loads.

Distribution of Loads on Locomotive Axles. A. T. J. Kersey. Gives mathematical investigation made to determine the distribution of the loads on the axles of a six-coupled tank engine. 1200 w. Engr, Lond—March 11, 1904. No. 61511 A.

The Dopp Adjustable Locomotive Scales (Die Dopp'sche Aichfähige Raddruckwage). F. Dopp, Jr. Illustrating an improved form of scales for weighing the distribution of pressure upon the wheels of a locomotive or railway carriage. 1200 w. Glasers Annalen—March 15, 1904. No. 61639 D.

Brake Control.

Brake Control of Heavy Capacity, Freight-Cars on Grade. T. A. Hedendahl. Discusses the influences bearing on the subject, with recommendations. General discussion. 6000 w. Pro Rocky Mt Ry Club—Feb., 1904. No. 61521 D.

Brakes.

Higher Braking Power for Freight Cars. Robert H. Blackall. Shows that a greater braking power is much to be desired to meet present conditions, and that it can be increased. General discussion. 9000 w. Ry Club of Pittsburg—Jan., 1904. No. 61192 C.

Cars.

The Lawson Dump Car. Illustrated detailed description. 900 w. R R Gaz—March 11, 1904. No. 61367.

Counterbalancing.

Counterbalancing Locomotives. G. E. Lee. Explains a method the writer has used with good results, giving an example from actual experience. 800 w. Mach, N. Y—March, 1904. No. 61204 C.

Engine Defects.

Locating Defects in Schenectady Cross Compound Engines. V. C. Randolph. Suggestions. 900 w. Loc Engng—March, 1904. No. 61274 C.

Fuel Tests.

Fuel Tests on the Furness Railroad, England. From a paper by W. F. Pettigrew, giving results of a series of tests made to determine the fuel value of several grades of coal. 1500 w. R R Gaz—March 4, 1904. No. 61247.

Inspection Cars.

Gasoline Inspection Cars for Railways. Illustrated descriptions of two new forms recently appearing in London. The inventions of Robert W. A. Brewer, and of Frederick R. Simms. 800 w. Sci Am Sup—March 19, 1904. No. 61438.

Locomotives.

Atlantic Type Passenger Locomotive for the Wabash Railway. Illustrations, principal dimensions and description of engine of the 4-4-2 type to handle heavy traffic. 700 w. Eng News—March 17, 1904. No. 61448.

Combustion Chambers in Italian Locomotives. Information concerning designs now in preparation which give a saving in repairs, and in earning time of the engines. 900 w. Engr, Lond—March 18, 1904. No. 61773 A.

Compound Locomotives in France. M. Edouard Sauvage. Details of locomotive practice, especially considering the four-cylinder compound. Many tables and illustrations. 12000 w. Inst of Mech Engrs —March 18, 1904. No. 61775 D.

Consolidation Locomotive for Southern Railway. Illustrations, general dimensions and description. 300 w. Ry Age—March 4, 1904. No. 61268.

Express Passenger Locomotive for the North-Eastern Railway. Illustrations, with principal dimensions of a new type of locomotive, the largest and most powerful ever built in England. 800 w. Engng —Feb., 19, 1904. No. 61150 A.

Heavy Freight Locomotive of the Atchison, Topeka & Santa Fé Railroad (Schwere Güterzuglokomotive der Atchison, Topeka & Santa Fé Bahn). H. Metzeltin. Illustrated description of new tandem-compound engines with table comparing American and European locomotives. 1800 w. Zeitschr d Ver Deutscher Ing—March 5, 1904. No. 6161[illegible] D.

New Six-Coupled Express Engine for the Great Western Railway. Charles Rous-Marten. Illustrated description. 800 w. Engr, Lond—March 18, 1904. No. 61774 A.

Pacific Type Engine, Union Pacific R R. Illustrated description of a recently built engine for heavy traffic. 500 w. Ry and Engng Rev—Feb. 27, 1904. No. 61136.

Six Coupled Passenger Locomotive. Illustrated description of a new design, 4-6-2 (Pacific) type, a very large and heavy engine. 1000 w. Am Engr & R R Jour—March, 1904. No. 61198 C.

Trials of the Great Western French Engine. Charles Rous-Marten. An interesting report of the satisfactory performance of this engine on two trips. 2500 w. Engr, Lond—March 4, 1904. No. 61418 A.

Two Locomotive Experiments. Corrects misconceptions in regard to experiments made with the new engine No. 102, La France, and the Decapod designed for suburban traffic on the Great Eastern Railway. 2800 w. Engr, Lond—Feb. 19, 1904. No. 61157 A.

Lubrication.

The Lubrication of Locomotive Valves and Cylinders. D. R. MacBain. Believes the trouble to be largely caused by wet steam. General discussion. 1600 w. Pro W Ry Club—Feb. 16, 1904. No. 61518 C.

Superheating.

The Use of Superheated Steam on Locomotives. A critical note on the Schmidt system, by M. Teuscher, and a long answer by Mr. Otto Berner, both appearing in the *Zeitschrift des Vereines deutscher Engenieure.* 12400 w. Bul Int Ry Cong—Feb., 1904. No. 61127 E.

Traction.

The Use of Double Traction (Note sur l'Emploi de la Double Traction). M. Herdner. A discussion of the action of two locomotives hauling a train, showing the practicability of dividing the work to advantage between the two machines. 4000 w. Rev Gen des Chem de Fer—March, 1904. No. 61676 H.

Train Lighting.

The Dick System of Lighting Trains by Electricity. Emile Guarini. Illustrated description. 800 w. Sci Am Sup—March 26, 1904. No. 61723.

Trials.

Trial Runs of Modern Locomotives. A. von Borries. A report of trials made in 1902, having as object the experimental comparison of the four cylinder compound locomotive on the von Borries system, with the most recent type of locomotive with superheated steam on the Schmidt-Garbe system. 4000 w. Bul Int Ry Cong —Feb., 1904. No. 61128 E.

Tunnel Ventilation

The Farcot Ventilator. (Ventilateurs Farcot). Ed. Sauvage. Data and results of tests of a large Farcot fan used for ventilating the Albespeyre tunnel in the south of France. Details of the machinery are given. 7500 w. Bull Soc d'Encour—Jan., 1904. No. 61644 G.

The Ventilation of the Albespeyre Tunnel (Aération du Tunnel de l'Albespeyre, Lozère). Illustrating an installation of the Saccardo system, with Farcot fan on the line of the Paris, Lyons, Mediterranean railway between Langogne and Alais, in southern France. 1200 w. Génie Civil—March 12, 1904. No. 61629 D.

Ventilation.

Ventilation of Baldwin Locomotive Works Engine House. Illustrated description of the system of carrying away the smoke and gases from locomotives. 500 w. Ry Age—March 25, 1904. No. 61751.

Wheels.

Chilled Cast Iron Car Wheels. J. S. Ferguson. Considers improvements made, outlining the practice of wheel casting as used by a reliable company, and the tests. 2500 w. Pro Rocky Mt Ry Club—Feb., 1904. No. 61522 D.

Specifications for Cast Iron Car Wheels. A copy of the standard specifications proposed by the committee of the American Society for Testing Materials. 2000 w. Ry & Engng Rev—Feb., 27, 1904. No. 61137.

Wrecking Appliances.

Modern Wrecking Appliances. Illustrates and describes recent improvements. 2200 w. Ry & Engng Rev—March 12, 1904. No. 61394.

Wrecking Outfits on the Pennsylvania. Describes the wreck trains and outfits, illustrating details of special tools carried. 2500 w. R R Gaz—March 11, 1904. No. 61360.

NEW PROJECTS.

China.

The Location of the First Division of the Hankow-Canton Ry. Jesse W. Miller. An interesting account of this survey and information concerning the country and its inhabitants. 3000 w. Eng News—March 17, 1904. No. 61453.

Genoa, Italy.

The Proposed New Railway Lines for the Development of the Port of Genoa, Italy. Charles R. King. Describes existing lines and the new projects for providing easier and cheaper transit inland. Ills. 2000 w. Eng News—March 24, 1904. No. 61705.

Improvements.

Pennsylvania Low-Grade Line Down the Susquehanna. Illustrated description of an important improvement made in the construction of a new double-track freight line, especially describing the stone bridge at Shocks Mills, Pa. 2200 w. R R Gaz—Marsh 11, 1904. No. 61364.

Russia.

Russian Railway Building in 1904 (Russlands Eisenbahnbauten im 1904). Brief tabulated statement of the amount to be expended and its distribution. 800 w. Glasers Annalen—Feb. 15, 1904. No. 61-634 D.

Switzerland.

The Albula Railway. The first of a series of illustrated articles giving a detailed technical account of the line joining Thusis and the Engadines. Involves very difficult construction work. 2500 w. Engr, Lond—March 4. 1904. Serial. 1st part. No. 61417 A.

Wabash.

The Wabash Extension into Pittsburg. Gives the history of this new line, with illustrations and descriptions of interesting construction work. 3800 w. R R Gaz—March 11, 1904. No. 61363.

PERMANENT WAY AND BUILDINGS.

Ballast.

Ballast. From the report of a committee to Am. Ry. Engng. & Main. of Way Assn. Explains the requirements of ballast, and considers the materials available. 3300 w. Eng Rec—March 26, 1904. No. 61740.

Coal Piers.

The Construction and Operation of Coal Piers. Abstract of a committee report prepared for the convention of the Am. Ry. Engng. and Main. of Way Assn. 5000 w. Eng News—March 17, 1904. No. 61452.

Construction.

The Construction of the Texas and Oklahoma Railroad. Robert F. Powell. Describes the construction work, illustrating details of interest. 2400 w. Eng Rec—March 5, 1904. No. 61239.

Curves.

See Civil Engineering, Measurement.

Drains.

Pillar Drains for Holding Banks. W. J. Cudworth. States the conditions which indicate a need of better drainage, and illustrates and describes the pillar drains used in England. 1000 w. R R Gaz—March 11, 1904. No. 61366.

Engine Houses.

A Comparison of Circular and Rectangular Engine Houses. Editorial discussion of George P. Nichols' paper before the Western Railway Club, with extracts. 3000 w. Eng News—March 3, 1904. No. 61223.

New Engine House Construction on the Intercolonial Ry. Illustrates and describes the engine house at St. John, N. B., giving information of a number of others. 1300 w. Ry & Engng Rev—March 12, 1904. No. 61393.

Square Roundhouses. George P. Nichols. Aims to show the disadvantages of the usual roundhouse form, and to demonstrate the superiority of the square house. General discussion. Ill. 3500 w. Pro W Ry Club—Feb. 16, 1904. No. 61517 C.

Improvements.

An Analysis of the Value of Recent Improvements on the Union Pacific. J. B. Berry. Abstract of a paper presented at the meeting of the Am. Ry. Engng. & Main. of Way Assn. Shows in a general way the work done, and gives a study of the operating statistics, summarizing the advantages and savings. 3500 w. R R Gaz—March 25, 1904. No. 61715.

Improvements on the Denver & Rio Grande. Brief description, with illustrations, of grade reductions, elimination of curvature, re-location, etc. 1400 w. R R Gaz—March 25, 1904. No. 61714.

The Improvements on the Big Four Line between Lawrenceburg Junction and Sunman. Describes the relocation of the line, grade reductions, and shortening of the line, explaining why the changes were made. Ills. 1300 w. Eng Rec—March 5, 1904. No. 61237.

Location.

The Location of the Knoxville, La Follette and Tellico Railroad, of the Louisville and Nashville System. W. D. Taylor.

Aims to show the considerations that determined each important step in the layout of an important engineering work. Maps. 7700 w. Pro Am Soc of Civ Engrs—Feb., 1904. No. 61177 E.

New Construction.

The Chicago, Indianapolis and St. Louis Short Line. Illustrates and describes a new cut-off being constructed at a cost of $3,000,000. It will reduce the distance from Indianapolis to St. Louis by 12 miles. 3300 w. R R Gaz—March 11, 1904. No. 61368.

Rails.

Specifications for Bessemer Steel Rails. Gives the specifications adopted by Am. Ry. Engng. & Main. of Way Assn. at the Chicago meeting. 900 w. Eng News—March 24, 1900. No. 61706.

Shops.

Fundamental Principles of Effective Organization and Economic Management Applied to R. R. Car-Repair Shops. Charles Streicher. A consideration of this subject, followed by general discussion. 5500 w. Pro Pacific C Ry Club—Feb. 20, 1904. No. 61516 C.

The Canadian Pacific Railway Shops at Montreal. An illustrated description of the power plant, electric installation, transportation, water system, heating, general construction and equipment. 4000 w. Eng Rec—March 19, 1904. Serial. 1st part. No. 61468.

The East Moline Shops of the Rock Island. An illustrated account of the electrical distribution and speed control, the location of machine tools and a description of the smith shop and store house. 3000 w. Ry Age—Feb. 26, 1904. No. 61108.

Signals.

Performance of Automatic Block Signals Under Unfavorable Conditions. H. S. Balliet. The first of a series of articles discussing the maintenance and operation of automatic signals. 2500 w. R R Gaz—March 25, 1904. Serial. 1st part. No. 61718.

Simplifying Night Signals and Shortening Block Sections. Criticism of points in a recent paper by A. M. Schoyer, before the Ry. Club of Pittsburg. 1500 w. R R Gaz—March 18, 1904. No. 61455.

Terminals.

New Passenger and Freight Terminals at Atlanta, Ga. Illustrates and describes a somewhat unusual arrangement, due to the peculiar shape of the property and differences in level of street and tracks. 800 w. R R Gaz—March 18, 1904. No. 61458.

Proposed Improvements in St. Louis Terminals. A. P. Greensfelder. Plans and description of the various improvements already made or contemplated, and an account of methods of handling the immense traffic. 7700 w. Jour Assn of Engng Socs—Jan., 1904. No. 61530 C.

The Union Terminal Arrangements at Washington. Illustrated explanation of work to be carried out with a view to securing beauty as well as usefulness, at a cost of about $20,000,000. 2500 w. Ry Age—March 18, 1904. No. 61590.

Ties.

Recent Investigations with Treated Ties. An article by Dr. Hermann von Schrenck, appended to the report of the Committee on Ties of the Am. Ry. Engng. & Main. of Way Assn. 1100 w. Eng Rec—March 26, 1904. No. 61734.

Tunnels.

See Civil Engineering, Construction.

Union Pacific.

Reduction of Gradient and Elimination of Distance, Curvature, and Rise and Fall on Union Pacific Railroad. J. B. Berry. An interesting account of extensive revision work so far accomplished, the methods adopted, and related matter of interest. 12500 w. Ry Age—March 18, 1904. No. 61591.

TRAFFIC.

Asia.

The Railways of Central Asia (Die Mittelasiatische Eisenbahn). P. Romanow. A general description of Russian railway developments between the Caspian Sea and the frontiers of Afghanistan, India, and China; with map. 5000 w. Zeitschr d Ver Deutscher Ing—Feb. 13, 1904. No. 61602 D.

Prussia.

The Administration of the Railway Service for the Year 1904 (Etat der Eisenbahn-Verwaltung für das Etatsjahr 1904). The official establishment of the Prussian railway system for 1904; tabulating the officials, expenditures and general outline of work for the year. Three articles. 10,000 w. Glasers Annalen—Feb. 15, Mar. 1, 15, 1904. No. 61631 each D.

Transsiberian.

The Siberian Railway and its Tributary Territory in Eastern Asia (Die Sibirische Eisenbahn und ihr Auschlussgebiet in Ostasien). Lieutenant Taubert. A general description of the journey from Berlin to Port Arthur, with a discussion of the country to be developed by the commercial operation of the line. 5000 w. Glasers Annalen—March 1, 1904. No. 61635 D.

The Siberian Railway and Its Results. Discusses this railway in connection with its influence on trade, and its effect on the present war, features of construction, etc. 3000 w. Engng—March 18, 1904. No. 61-771 A.

STREET AND ELECTRIC RAILWAYS

Bagdad.

Details of the New Constantinople-Bagdad Railway. Information concerning this new line, which, with its branches, will have a length of 1,500 miles. 900 w. Sci Am Sup—March 5, 1904. No. 61282.

Boston.

The Boston Transit Problem. Illustrated detailed description of the construction of this great engineering work, with explanation of the way it meets the needs of transportation of the city. 2800 w. Ry Age —March 18, 1904. No. 61586.

Brake Service.

Method of Making Competitive Tests of Capacity, Power Consumption, and Efficiency of Motor-Driven Compressors for Brake Service. Edward H. Dawson. Describes method. 1700 w. St Ry Jour—Feb. 27, 1904. No. 61118 C.

Cars.

A Double-Deck Car for Rapid Transit. Remarks on the advantages of the double-deck cars, with illustrated description of a design by James L. Getaz. 800 w. Sci Am —March 19, 1904. No. 61434.

Chicago Tunnels.

Electric Traction for Freight Transportation in the Chicago Telephone Tunnels. An illustrated article describing the utilization of these tunnels for the handling of mail, express, and freight. 900 w. Eng News—March 17, 1904. No. 61450.

Compressed Air.

Compressed Air in Electric Railway Shop, Power House and Track Work. An illustrated article reviewing the uses to which air under compression can be applied, and the methods and devices used. 7000 w. St Ry Rev—March 20, 1904. Serial. 1st part. No. 61726 C.

Cranford.

The Cranford Plant of the Public Service Corporation of New Jersey. A building constructed of concrete blocks and a system of piping that includes a steam header 81 feet long without a single valve in it are conspicuous features of this electric railway plant. 3000 w. Eng Rec—March 19, 1904. No. 61469.

Electric Traction.

Electricity as a Substitute for Steam in Heavy Railroad Service. Arthur M. Waitt. Considers features relating to the practicability of the introduction of electricity on roads now using steam. 4800 w. Ry Age—March 4, 1904. No. 61267.

How Can We Haul by Electric Locomotives Freight Trains Weighing Twice as Much as Those Now Hauled by Steam Locomotives? H. Ward Leonard. Gives statistics showing the average train loads and cost of hauling, and predicts that economics will be effected by the use of electric locomotives. 600 w. Elec Wld & Engr—Feb. 27, 1904. No. 61110.

Past, Present and Future of Electric Traction. Frank J. Sprague. Reviews features in the development. 3000 w. Elec Wld & Engr—March 5, 1904. No. 61343.

The Electrification of the Liverpool and Southport Railway. An illustrated detailed description of this new departure. 7000 w. Engng—March 18, 1904. No. 61-769 A.

The First Commercial Electric Street Railway in America. An illustrated account of the line in Baltimore, opened August 10, 1885, and interesting matters related. 2200 w. Elec Wld & Engr—March 5, 1904. No. 61340.

The First Electric Street Car in America—1884. E. M. Bentley. An account of the opening of a line a mile long in Cleveland, Ohio, the system installed, the difficulties, &c. Also notices of other early work in this field. 2500 w. Elec Wld & Engr—March 5, 1904. No. 61336.

English Tramways.

The Railways and the Tramways. Editorial discussion of the attitude of the great railways toward the tramways. 2000 w. Engng—Feb. 19, 1904. No. 61151 A.

Escalator.

The Escalator. Charles D. Seeberger. Illustrated description of a moving stairway. Cassier's Mag—March, 1904. No. 61585 B.

France.

The French Railways and Tramways in 1902. C. Colson. A review of the lines, their earnings, needed expenditure, and the general condition. 3000 w. Bul Int Ry Cong—Feb., 1904. No. 61130 E.

Isle of Man.

The Manx Electric Railway. Illustrated description of an interesting and picturesque road. 9500 w. St Ry Jour—March 5, 1904. No. 61260 C.

Jungfrau.

The Jungfrau Railway. Points of interest in regard to this unique railway of Europe, which is to be carried 4,093 meters above sea level. Ills. 1800 w. St Ry Rev—March 20, 1904. No. 61729 C.

Light-Railway.

The Barking-Becton Light Railway. Illustrates and describes the interlocking devices which control the opening of the bridge which crosses the river Roding, and gives information concerning the line. 1500 w. Elect'n, Lond—Feb. 26, 1904. No. 61302 A.

London.

London Traffic—An Unsolved Problem. J. Swinburne. Discusses the conditions in London, suggesting means of improving them. 4000 w. Cassier's Mag—March, 1904. No. 61582 B.

The Great Northern and City Railway. An illustrated description of London's latest "tube," with facts concerning it. 3500 w. St Ry Jour—March 5, 1904. No. 61259 C.

The London Traffic Problem. Brief review of changes in modes of conveyance, outlining an ideal system, and describing existing conditions and facilities, discussing possible solutions. Ills. 6200 w. Tram & Ry Wld—March 10, 1904. No. 61593 B.

Los Angeles.

Organization and Operating Features of the Pacific Electric Railway Company's System. Discusses in detail interesting operating features in Los Angeles and interurban systems. Ills. 4500 w. St Ry Jour—March 26, 1904. No. 61750 C.

The Pacific Electric Railway Company's System. Gives a map of the region around Los Angeles, Cal., showing the various lines, and an illustrated description of the distinctive points of the physical features and operation of this road. 4800 w. St Ry Jour—Feb. 27, 1904. Serial. 1s part. No. 61115 C.

Lubrication.

Street Car Lubrication. George L. Fowler. Considers the variation in practice and discusses the importance of the subject, and means of securing the best results. 2200 w. St Ry Jour—March 19, 1904. No. 61479 C.

Main Lines.

Electrification of the Liverpool-Southport Line—L. & Y. Railway. J. A. F. Aspinwall. A full illustrated account of the first main line steam railway in England to be partially equipped for handling passenger traffic by electric power. 8500 w. Mech Engr (Sup.)—March 19, 1904. No. 61762 A.

The Railway Electrification Problem. F. F. Bennett. Read before the Inst. of Elec. Engrs. Discusses the question as related to traffic in England and Wales. 2000 w. Mech Engr—March 12, 1904. Serial. 1st part. No. 61490 A.

Manchester, Eng.

The Tramway System of Manchester. An illustrated account of the tramway system as now completed. 10500 w. Tram & Ry Wld—March 10, 1904. No. 61592 B.

New York.

New York and Its Urban Traffic. From *Zeitung des Vereins*. An interesting review of the means of transport, with map and explanation of conditions. 5000 w. Bul Int Ry Cong—Feb., 1904. No. 61129 E.

New York Rapid Transit. F. O. Dufour. Reviews the attempts made to secure rapid transit for New York, describing the construction of the underground railway and giving its history. Ill. 4200 w. Wis Engr—Feb., 1904. No. 61180 D.

Ohio.

Electric Railways in Ohio. A statement of the present conditions in the State, showing great progress, and also stating the causes which have retarded the building of electric railways. 2800 w. St Ry Jour—March 12, 1904. No. 61378 C.

The Western Ohio Railway Co. Illustrates and describes the company's lines, power house, sub-stations, etc., with a revie wof some operating details. 5000 w. St Ry Rev—March 20, 1904. No. 61725 C.

Pacific.

Power Station, Rolling Stock and Dispatching System of the Pacific Electric Railway Company. Illustrated detailed description. 5500 w. St Ry Jour—March 12, 1904. No. 61377 C.

Power House.

Equipment of a Large French Railway Power House. C. Domar. Illustrated description of a generating station for the Paris, Metropolitan road. 3000 w. Am Elect'n—March, 1904. No. 61208.

Rail Joints.

Cast-Welded Joints. Albert B. Herrick. Reviews the history of these joints and the difficulties encountered, with some facts in regard to their value. 1200 w. St Ry Jour—March 5, 1904. No. 61262 C.

Rail Joints and Their Relation to Pavements. C. R. Van Buskirk. Read before the Brooklyn Engrs.' Club. Reviews the troubles that have been experienced and advocates the use either of the Weber joint, or welding. 3000 w. St Ry Jour—Feb. 27, 1904. No. 61117 C.

Railway Motors.

The Alternating Railway Motor Situation. Louis Bell. Briefly considers the various systems for operating electric roads, discussing the motors already brought into notice. 2000 w. St Ry Jour—Feb. 27, 1904. No. 61116 C.

Rapid Transit.

Section Five A, Second Division, New York Rapid Transit Railroad. Illustrated description of a section passing from 41st Street and Park Avenue to 47th Street and Broadway, and containing many difficult problems. 2000 w. Eng Rec—March 5, 1904. No. 61236.

Repairs.

Repair Shop Practice of the Pacific Electric Railway Company. Illustrated description of the Los Angeles shops and their equipment. 6500 w. St Ry Jour—March 19, 1904. No. 61478 C.

Sanding.

Sand Braking for Tramways (Sandbremse für Elektrische und andere Bahnen). Describing an electrically-operated sand box and distributor for tramway use. 1000 w. Glasers Annalen—Feb. 15, 1904. No. 61633 D.

Single Phase.

Single-Phase Electric Railways (Ueber Einphasenbahnen). Dr. Friedrich Eichberg. An address before the Vienna Elektrotechnischen Verein, reviewing the recent successful applications of single-phase railway motors. Two articles. 5000 w. Zeitschr f Elektrotechnik—Feb. 28, March 6, 1904. No. 61663 each D.

Single-Phase Electric Traction. W. Perren Maycock. A comparison of the single-phase and direct-current methods, discussing the advantages of the former. 1800 w. Trac & Trans—March, 1904. No. 61320 E.

The Single-Phase Railway System of the Union Elektrizitäts-Gesellschaft (Das Einphasen-Bahnsystem der Union Elektrizitäts - Gesellschaft). Dr. Friedrich Eichberg. Describing especially the experimental work on the Nieder-Schöneweide - Spindlersfeld experimental line. 2500 w. Zeitschr d Ver Deutscher Ing—Feb. 27, 1904. No. 61609 D.

The Ward Leonard Single-Phase Locomotive. G. T. Hanchett. An illustrated description of this system, with a statement of the advantages and disadvantages over the ordinary heavy system of multiple unit direct-current traction. 2500 w. Elec Wld & Engr—March 5, 1904. No. 61344.

Sub-Stations.

Equipment of Sub-Stations — North-Eastern Railway. Illustrates and describes very interesting plants. 1500 w. Tram & Ry Wld—March 10, 1904. No. 61594 B.

Substructure.

Steel Railroad Substructure. A system of supporting railroad rails on a continuous line of inverted trough-shaped girders, invented by Samuel E. Duff, is illustrated and described. 1200 w. R R Gaz—March 11, 1904. No. 61365.

Subway.

Progress on the East Boston Subway. Describes interesting construction work on this tunnel, which passes under Boston Harbor and under the streets of the city. Ills. 4000 w. Ry & Engng Rev—March 12, 1904. No. 61395.

Switzerland.

Swiss Electric Railroading. Franz Koster. Illustrated description of the Lausanne-Moudon railway system. 1600 w. Elec Rev, N Y—March 5, 1904. No. 61-270.

Through Booking.

Through Booking and Conveyance of Passengers, Parcels and Merchandise on Tramways and Light Railways. T. Upton. A discussion of the phases of the subject from an English point of view. 1500 w. Elec Rev, Lond—March 11, 1904. Serial. 1st part. No. 61497 A.

Trolley.

A New Form of Trolley for Electric Railways (Ueber eine Neue Stromzufuhrungsanlage für Elektrische Bahnen). E. Thomann. Illustrating and describing an improved form of sliding contact trolley, enabling current to be taken from overhead wires by the side of a main-line railway track. 2500 w. Schweiz Bauzeitung —Feb. 13, 1904. No. 61646 B.

Electric Locomotive with Overhead Trolley (Locomotive Electrique et Prise de Courant pour Ligne Aérienne). Illustrating a locomotive with improved sliding-contact trolley, built by the Oerlikon works. 1000 w. Génie Civil—March 12, 1904. No. 61630 D.

Urban Traffic.

The Encouragement of Urban Traffic. R. W. Western. Reaches the conclusion that it is wiser to study the passenger's time than his comfort, and considers the ways of securing rapid service. 2400 w. St Ry Jour—March 20, 1904. No. 61730 C.

Wheels.

Steel-Tired Wheels on the Boston Elevated Railway System. Illustrates and describes the methods adopted to keep the wheels absolutely round, and the repairs to the wheels. 1600 w. St Ry Jour—March 26, 1904. No. 61749 C.

The Fused Steel-Tired Wheel. Knox Taylor. Illustrates and describes a wheel of American production coming into service for high-speed electric railways. 1400 w. St Ry Jour—March 5, 1904. No. 61-261 C.

Zanesville, O.

Zanesville Railway Light and Power Co. Illustrated description of this company's new plant, which comprises a steam turbine equipment and a water-power plant, combined with storage battery for reserve. 2500 w. St Ry Rev—March 20, 1904. No. 61727 C.

EXPLANATORY NOTE—THE ENGINEERING INDEX.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language*, together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. Certain journals, however, make large extra charges for back numbers. In such cases we may have to increase proportionately the normal charge given in the Index. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* Boston.
American Electrician. *m.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Jl. of Science. *m.* New Haven, U.S.A.
American Machinist. *w.* New York.
American Shipbuilder. *w.* New York.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. d Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *qr.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Sydney.
Autocar. *w.* Coventry, England.
Automobile. *m.* New York.
Automobile Magazine. *m.* New York.
Automotor Journal. *w.* London.
Beton und Eisen. *qr.* Vienna.
Brick Builder. *m.* Boston.
British Architect. *w.* London.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bulletin American Iron and Steel Ass'n. *w.*
Philadelphia, U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. Soc. Int. d Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bulletin Univ. of Kansas. *b-m.* Lawrence.
Bull. Int. Railway Congress. *m.* Brussels
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Montreal.
Canadian Mining Review. *m.* Ottawa.
Cassier's Magazine. *m.* New York.
Central Station. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Deutsche Bauzeitung. *b-w.* Berlin
Domestic Engineering. *m.* Chicago.
Electrical Engineer. *w.* London.

Electrical Review. *m.* London.
Electrical Review. *w.* New York.
Electrical World and Engineer. *w.* New York.
Electric Club Journal. *m.* Pittsburg, Pa.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *w.* New York.
Electrochemical Industry. *m.* New York.
Electrochemist and Metallurgist. *w.* London.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Chicago.
Engineering. *w.* London.
Engineering and Mining Journal. *w.* New York.
Engineering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York
Engineering Review. *m.* London.
Eng. Soc. of Western Penna. *m.* Pittsburg, U.S.A.
Engineering Times. *m.* London.
Fire and Water. *w.* New York.
Foundry. *m.* Cleveland, U. S. A.
Gas Engineers' Mag. *m.* Birmingham.
Gas World. *w.* London.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e. d. Str. Ferr. *w.* Rome.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Ice and Refrigeration. *m.* New York.
Ill. Zeitschr. f. Klein u. Strassenbahnen. *s-m.* Berlin.
Ingenieria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron and Steel Metallurgist. *m.* Boston.
Iron and Steel Trades Journal. *w.* London
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. Am. Foundrymen's Assoc. *m.* New York.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Journal of Sanitary Institute. *qr.* London.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery *b-m.* Fort Monroe, U.S.A.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, U.S.A.
Locomotive. *m.* Hartford, U. S. A.
Locomotive Engineering. *m.* New York.
Machinery. *m.* New York.
Madrid Cientifico. *t-m.* Madrid.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U. S. A.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Metal Worker. *w.* New York.
Métallurgie. *w.* Paris.
Minero Mexicano. *w.* City of Mexico.
Minerva. *w.* Rome.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci Press. *w.* San Francisco.
Mining Reporter. *w.* Denver, U. S. A.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
Modern Machinery. *m.* Chicago.
Mouvement Maritime. *w.* Brussels.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *m.* New York.
Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Nineteenth Century. *m.* London.
North American Review. *m.* New York.
Oest. Wochenschr. f. d. Oeff Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg- & Hüttenwesen. *w.* Vienna.
Ores and Metals. *w.* Denver, U. S. A.
Pacific Coast Miner. *w.* San Francisco.
Page's Magazine. *m.* London.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Proceedings Engineers' Club. *qr.* Philadelphia.
Pro. St. Louis R'Way Club. *m.* St. Louis, U. S. A.
Progressive Age. *s-m.* New York
Quarry. *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago
Review of Reviews. *m.* London & New York.
Revista d Obras. Pub. *w.* Madrid.
Revista Tech. Ind. *m.* Barcelona.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Gen. des Sciences. *w.* Paris.
Revue Industrielle. *w.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Gen. d Ferrovie. *w.* Florence.
Rivista Marittima. *m.* Rome.
Schiffbau. *s-m.* Berlin.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Engng. *m.* Ithaca, N. Y.
Stahl und Eisen. *s-m.* Düsseldorf.
Stevens' Institute Indicator. *qr.* Hoboken U.S.A.
Stone. *m.* New York.
Street Railway Journal. *m.* New York.
Street Railway Review. *m.* Chicago.
Tijds. v h Kljk. Inst. v Ing. *qr.* Hague.
Traction and Transmission. *m.* London.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Transport. *w.* London.
Wiener Bauindustrie Zeitung. *w.* Vienna.
World's Work. *m.* New York.
Yacht. *w.* Paris.
Zeitschr. d. Mitteleurop. Motorwagen Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a S.
Zeitschr. f. Electrotechnik. *w.* Vienna.

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THE SYSTEM OF APPRENTICESHIP AT THE BALDWIN LOCOMOTIVE WORKS.

By S. M. Vauclain.

The success of the Baldwin Locomotive Works in dealing with their employees is everywhere known. We congratulate ourselves and our readers on being able to present this account of the very basis of this success, by so distinguished an author.—THE EDITORS.

THE technical papers have been devoting considerable space to the discussion of the labor problem from the point of view of the method of payment of labor. Many plans for bringing about a more harmonious relation between labor and capital have been suggested, the crux of these plans being the substitution, for definite rates per day, of piece work on a sliding scale, bonus, division of profit, or some similar system. None of the propositions has received the hearty approval of the workingman, and all theorizing notwithstanding, the straight day and straight piece-work system of pay find the most favor with the labor element. We have but to look back over the past two years to learn that plans of this kind have been far from successful in accomplishing their ends, for they have rather tended to separate the working man and employer by even a wider gap.

A specialist of such high repute as Carrol D. Wright has maintained that the solution of the labor problem must include some scheme of division of profit. Unfortunately, however, "Profit and Loss" are twin sisters, and the weakness of such propositions consists in the fact that they accentuate the difference between prosperous times and periods of business depression, and that they do least for the workingman during the times of most urgent need. The most

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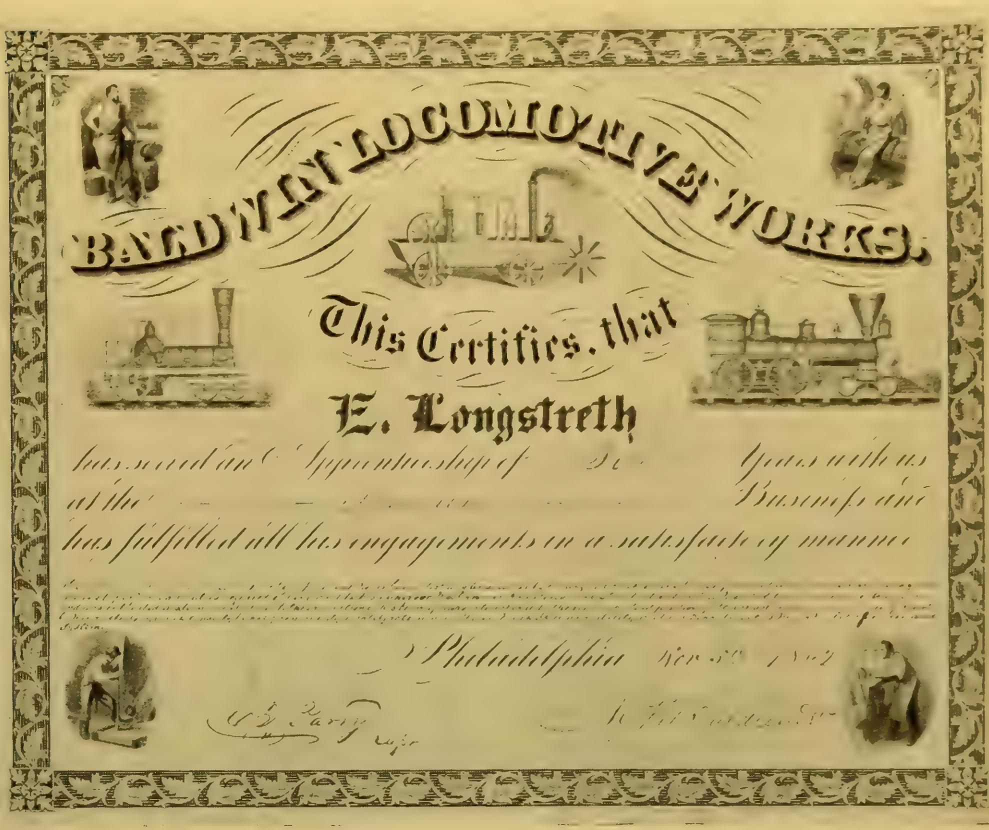
A CORNER OF THE BALDWIN LOCOMOTIVE WORKS.

pretentious plan of making business partners of the working man has been inaugurated by the United States Steel Corporation, the greatest employer of men the world has ever seen. The proposition, which is as broad and liberal as can be desired, was heralded far and wide as a panacea for labor troubles, and the employees of the company eagerly availed themselves of the opportunities offered—while the business of the company was prospering. A short year after the origination of this plan, the depression in the steel industry and the fall in the market value of the shares had a deterrent influence upon the workingmen and they were not so eager to become partners in a business in which there was even a possibility of a failure to bring future returns upon the money they might have to invest, even though the immediate returns promised a high rate of interest.

The factory which has for its cardinal principles, fair treatment of its men, the payment of an honest day's pay for an honest day's work, and which instills into its employees principles of loyalty and honesty, need have no fear of labor troubles. It is the record of the Baldwin Locomotive Works that they have never had a strike, neither do they discriminate in favor of or against the union men. The workmen know that the latch string to the head of the establishment is always out, and that any one, of whatsoever station, can secure a respectful hearing of any grievance he may have. It takes years of good faith before the workingmen can understand that principles such as these are traditions of a plant, and if such traditions are to be kept alive they must be instilled into a sufficient number of men to form the back bone of the later element. It is a difficult matter to teach an old dog new tricks, so that the apprentices offer the most fertile field for the development of a good, loyal body of men.



BALDWIN LOCOMOTIVE WORKS.

This Certifies that

E. Longstreth

has served an Apprenticeship of Years with us

at the Business and

has fulfilled all his engagements in a satisfactory manner

Philadelphia

The four lines of fine text on the certificate read as follows: "He has during his apprenticeship ever been punctual, never having lost any time, either by coming late or absenting himself without leave, and always ready and willing to perform all duties required of him, and by his superior mechanical knowledge and strict attention has merited the confidence of the firm, and was entrusted 16 months prior to the expiration of his term of apprenticeship with the very important position of 'Foreman,' having daily charge of about 60 men and boys, in which capacity he has given us entire satisfaction and shown much skill and ability and his department is now a model of order and system."

The Baldwin Locomotive Works have always maintained a system of apprenticeship, and the certificate of Mr. Edward Longstreth (shown in illustration) who rose from the apprentice's rank to that of a proprietor, is evidence not only of the establishment of the system in the early sixties, but also as to its effectiveness. In January of 1901, however, a new system was inaugurated in which the apprentices were divided into three classes. The different classes and requirements are shown in Diagram I; the horizontal lines represent the number of apprentices employed and the vertical lines their age and occupation, from which it will be seen that there are:—

1.—First-class apprentices, of whom there were 232 in service on the first of January 1904; they are required to have a good common-school education and are not to be over 17 years and 3 months of age. They are indentured for four years, and are required to attend a free night school for at least two evenings in each week during the first three years of the apprenticeship. The first year the apprentice is expected to take up elementary algebra and geometry, and the rudiments of mechanical drawing during the remainder of the two years.

2.—Second-class apprentices, of whom there were 99 in service on the first of January 1904. Applications for indenture in this class are considered from boys who have an advanced grammar or high-school training and who are not over 18 years of age. The term for this class is three years, and the apprentices are required to attend night school which shall teach them the rudiments of mechanical drawing for the first two years of the indenture.

3.—Third-class indenture; this is in the form of an agreement with young men of 21 years of age, who are graduates of colleges, technical schools, or scientific institutions, having courses in the higher mathematics, natural science, and drawing. They are not required to attend any night classes, but in lieu of this must read some technical journal, and turn in a synopsis of all the articles of some journal. This matter is used for indexing the articles in the publication. The indenture in each case places upon the firm the obligation to teach the apprentice thoroughly his art, and to furnish him abundant opportunity to acquire a practical knowledge of the business. The employer is also bound to retain the apprentice in service until he has completed the term provided for in the indenture, with the reservation of the right to dismiss the apprentice for cause.

The rates of pay are shown in Diagram 2; this diagram also shows how well the works discharge the obligation to the apprentice, for these statements have been compiled from actual cases and show the work upon which the apprentices are engaged for each three months of service. The photographs also show the character of the work in which the apprentices are given an opportunity to acquire skill. It will be seen that the apprentices are changed every three months, and the first-year apprentice is given experience of such an

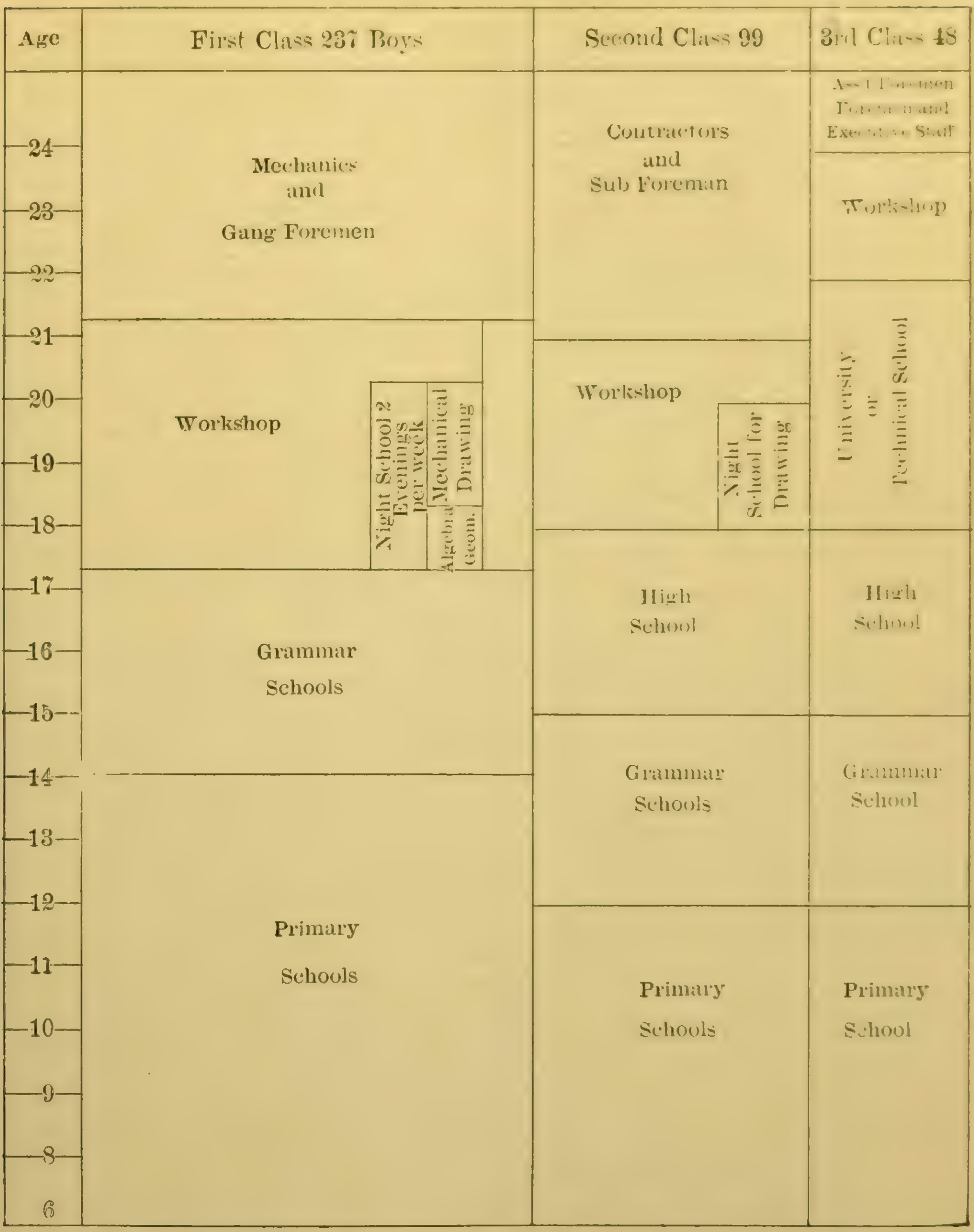


DIAGRAM I. CLASSES AND REQUIREMENTS OF APPRENTICES, BALDWIN LOCOMOTIVE WORKS.

extended character as to make him a first-class and thorough mechanic. At the end of his service he is given a bonus of $125; he is then at liberty to sever his connection with the works, and has the means of travelling half-way across the continent in search of a job satisfactory to him.

It will be seen, as shown in Diagram I, that the course for the first-class apprentices is designed to develop first-class mechanics and men for positions of minor responsibility; the object of the course for the second class is to develop men for the positions of contractors and sub-foremen; and the assistant foremen, foremen, and executive staff, are developed from the third class of apprentices, although no limitation is placed upon the height to which any class of apprentice may aspire or rise, and the first class of apprentices may and do rise to places of higher responsibility than those held by the third class.

First Class		Second Class		Third Class	
1st Year 5¢	Planer Planer Shaper Slotter	1st Year 7¢	Shaper Planer Lathe Bench Work	1st 6 months 13 ¢	Lathe Bench Work
2nd Year 7¢	Slotter Bench Work Bench Work Lathe	2nd Year 9¢	Planer Boring Mill Bench Work Bench Work	2nd 6 months 16 ¢	Planer Shaper Highway Office
3rd Year 9¢	Test Room Planer Shaper Erecting Gang	3rd Year 11¢	Boring Cylinders Planing Cylinders Erecting Gang Erecting Gang	3rd 6 months 18 ¢	Test Department Valve Gang
4th Year 11¢	Erecting Brass Work in Erecting Shop Throttle Gang Valve Gang			4th 6 months 20 ¢	Erecting Gang Track Foreman
Bonus $125		$100		——	

DIAGRAM 2. RATES OF PAY OF APPRENTICES, BALDWIN LOCOMOTIVE WORKS.

It is very essential that men holding positions of responsibility should acquire a habit of making observations and keeping record of them, and in this manner develop habits which will prove very valuable to them when asked to look after the work of several men or the material required for a gang or shop. In order to systematize this work a form is provided for the second and third class of apprentices which each is required to fill in. This form contains all the data necessary to establish piece-work prices; the better class of apprentices are thus organized into an elemental rate-fixing department, and information is secured from which can be obtained a very accurate estimate of the cost of labor or of any piece of work. The superintendent of apprentices also secures a very accurate knowledge of the work being done by each apprentice and a means for comparing the work of the different apprentices.

The management carefully guard against any tendency towards paternalism, in an effort to bring out the individual qualities of the apprentices, and with the belief that the apprentices will develop into better and stronger men if they are compelled to rely upon their own resources. There are no special lectures and no clubs or social features; the blue overalls level all social distinction; princes and sons of men of wealth work shoulder to shoulder with those less favored, and it is such an everyday experience as to call for no comment.

No._____

Machine Inspection

Shop__________Foreman__________Machine____________No.__________Date___________

Contractor_____________Class of work__________________Card____________

Material____________________Engine________________________

Operation	Size of tool	R. P. M.	Feed	Depth of cut	Speed	Total time	Average time	Minimum time

Remarks:

Tool steel used

Apprentice______________________

DATA SHEET TO BE FILLED IN BY SECOND AND THIRD-CLASS APPRENTICES.

Since January 1st, 1901, at which time the present system of apprenticeship was inaugurated under the supervision of Mr. N. W. Sample, there have been indentured five hundred and forty-five apprentices; three hundred and fifty-two first-class, one hundred and twenty-four second-class, and sixty-nine third-class. Of this number one hundred and fifty-three, or about 28 per cent., have been discharged for reasons other than expiration of their terms of apprenticeship. The total number of apprentices carried on the shop rolls at the close of the year 1903 was three hundred and seventy-nine, of

AT WORK IN THE BRASS SHOP.

MOULDING CYLINDERS IN THE FOUNDRY.

which number three hundred and forty-five are machinists, five blacksmiths, five brass finishers, ten moulders, twelve pattern makers, one boiler maker, and one sheet-iron worker. There are two hundred and thirty-two first-class, ninety-nine second class, and forty-eight third-class.

In addition to indentured apprentices there are twenty-three special apprentices, largely from foreign countries, one being a native of Finland, one of Costa Rica, two of San Domingo, five of Cuba, one of Spain, four of Japan, three of Porto Rico, and one of Mexico.

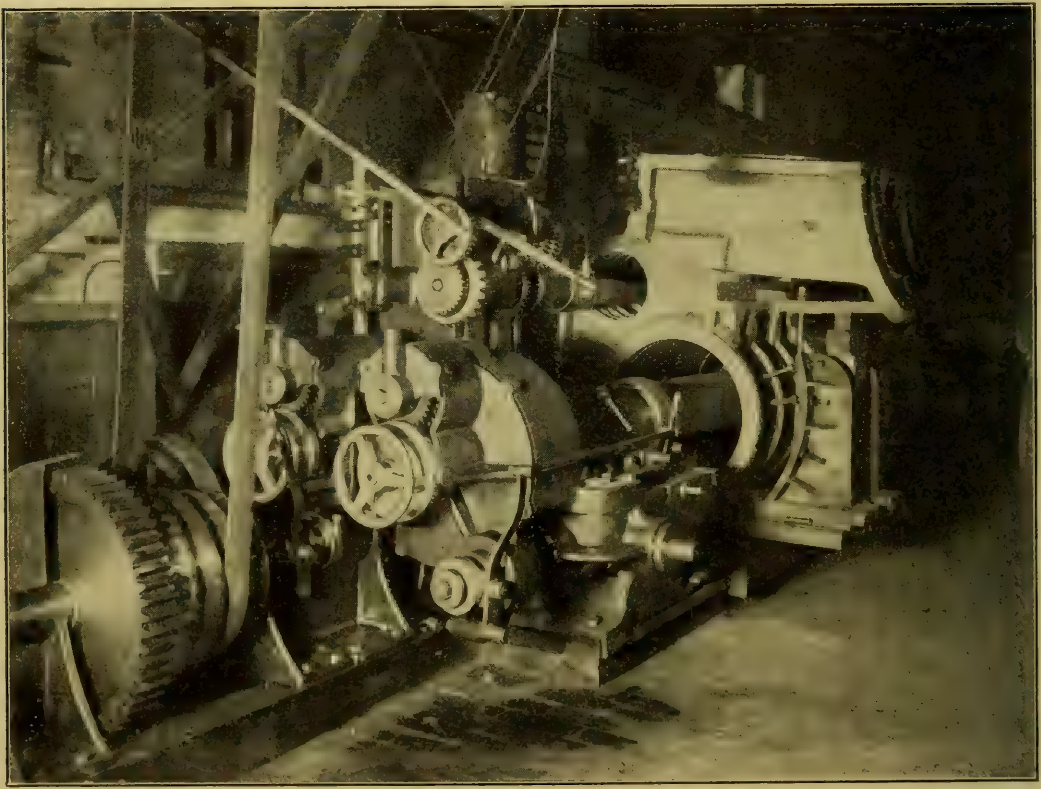
THE BLACKSMITH SHOP.

The number of apprentices indentured during the year 1903 was one hundred and sixty-five; of this number one hundred and fifty-six were indentured to the machinists' trade, five to the trade of pattern making, one to brass finishing, one to moulding, and one to boiler making. There are ninety-seven first-class, forty second-class and twenty-eight third-class. There have been sixty-one apprentices discharged during the year and thirteen dropped from the rolls by reason of expiration of apprenticeship.

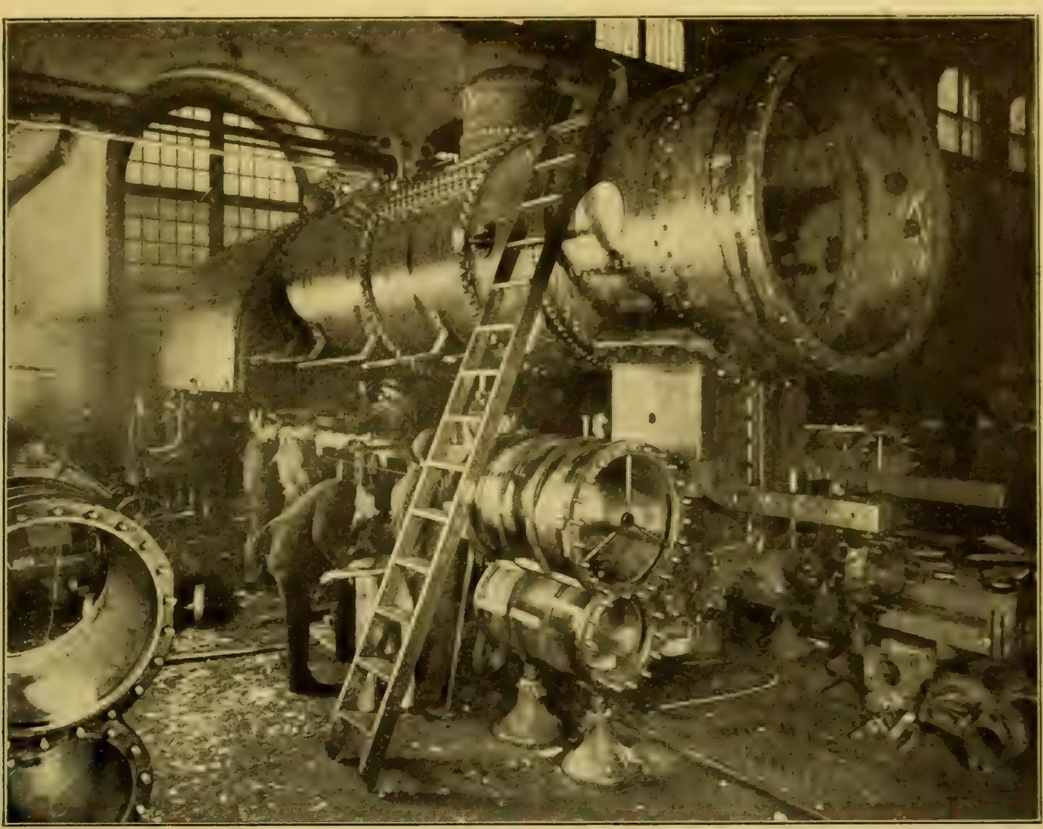
Two apprentices in the first class completed their terms during the year. Both are exceptionally good hands, and at the expiration of their time were employed as machinists. Eleven apprentices in the third class completed their terms during the year; six of this number have been promoted to places of responsibility in the erecting and machine shops and in the maintenance department; five others are employed as machinists in the erecting shop.

During the year 1904 fifteen first-class, thirty-one second-class, and nineteen third-class apprentices will complete their terms of apprenticeship. The attendance of the apprentices at the second term of the school year, commencing January 5th, and ending February 25th, 1903, was 63 per cent. of all the first and second-class boys on the rolls at the opening of the term, and it is expected that the percentage of attendance for the present year will be even greater.

These figures show that the Baldwin Locomotive Works are doing their share to prevent "race suicide" of the trades worked upon in their establishment. It will also be seen that the plan is not altogether a philanthropic one, for the incorporation of the several features mentioned before make the system self-supporting. The chief advantage, however, is the development of a loyal, brainy set of men with a thorough training in the mechanic arts and especially developed in certain lines. Those of them that remain will lend their energy to assisting and building up the business of their employers, and are



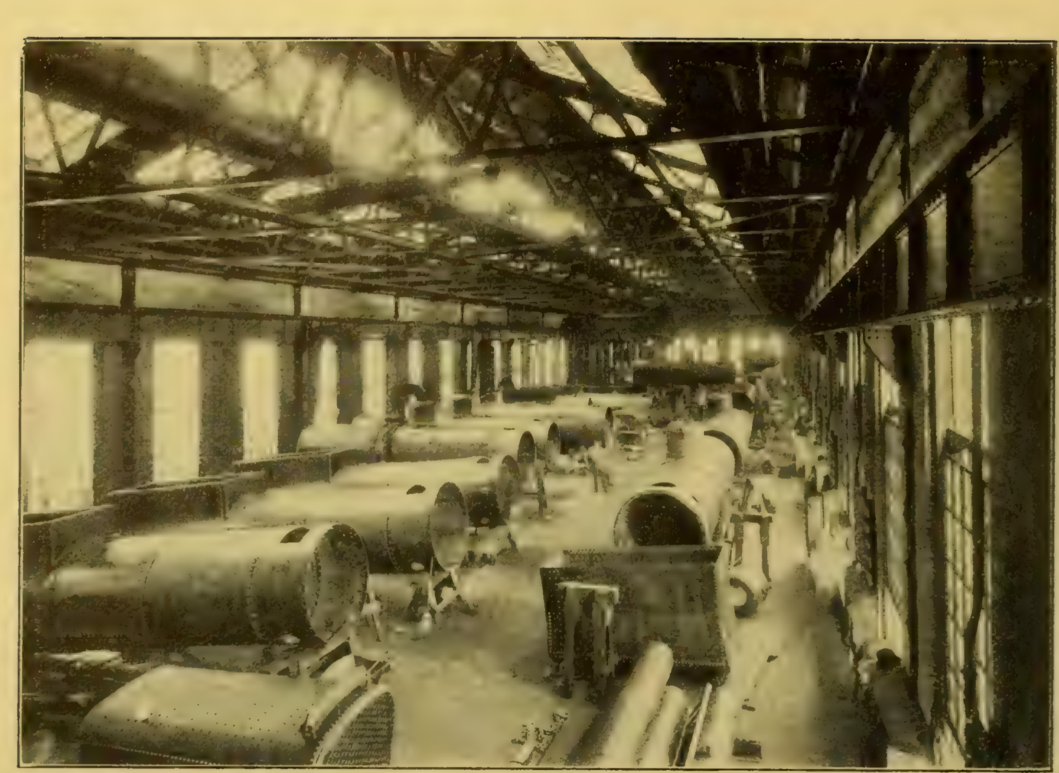
BORING CYLINDERS. THE TWO CYLINDERS AND THE VALVE CHEST OF A VAUCLAIN COMPOUND ARE BORED AT ONE OPERATION.



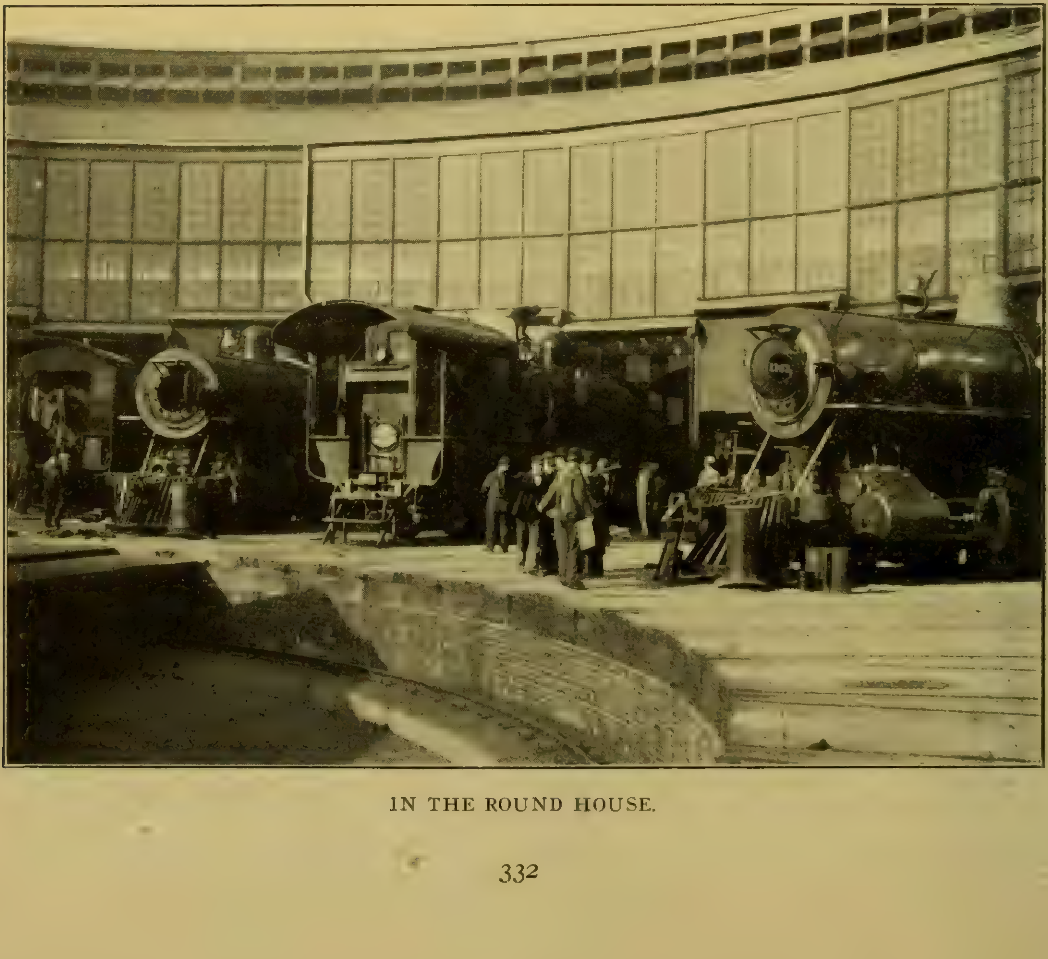
A THIRD-YEAR APPRENTICE IN CHARGE OF A GANG LINING UP AN ENGINE.

just as proud of the works and its accomplishments and just as jealous of its reputation as the proprietors themselves, for they consider themselves the children of the works. The manufacturing plant that has a loyal, intelligent body of workmen who make their employers' interest their own, has the very best equipment for meeting the strenuous competition of the present day. Mr. George S. Morison sums up the situation in "The New Epoch" as follows:

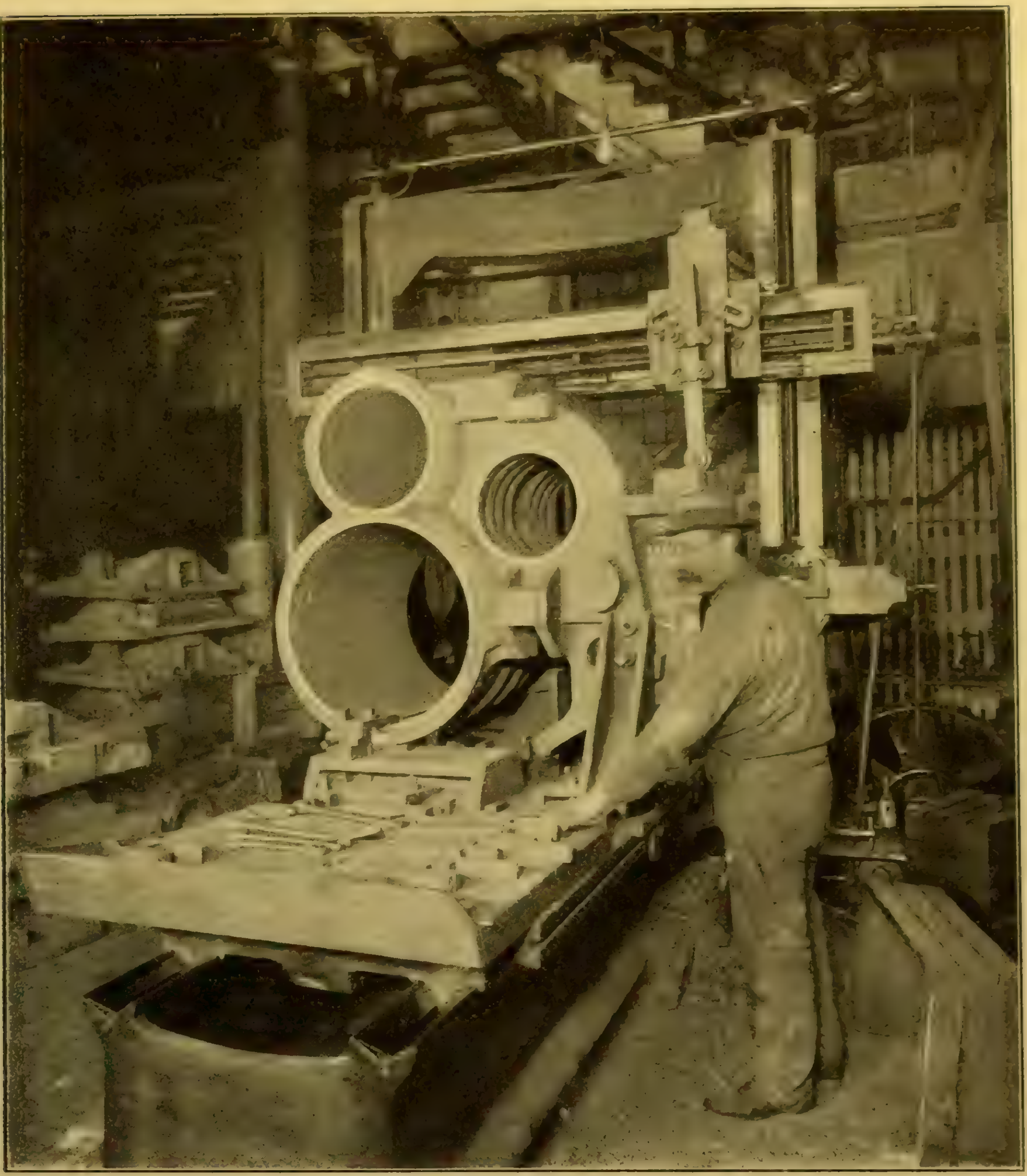
> "The profits of the new epoch must be made, not by buying cheap and selling dear, but by reducing the cost of production. The most successful man will not be the one who has the shrewdest salesman to dispose of his goods, but the one who can manufacture his wares more cheaply than any one else engaged in the same work. The most successful transportation line will not be the one whose agents are the most active in securing business, but the one which is the most closely handled, which can carry its freight at a less cost to itself to any competing line. Permanent success will depend not on commercial drummers, but on the engineer; not on the shrewd guesses of the so-called business men, but on the accurate knowledge of the manager who knows what his tools are, who knows what it costs to produce, who knows the defects of his plant and the features in which it may be improved, who, in fact, is applying all the intelligence of an educated mind, not to getting the better of some other man who may know a little less, but to getting the best work possible for himself and his employers out of what he has to work with."



THE FITTING-UP FLOOR OF THE BOILER SHOP.



IN THE ROUND HOUSE.



PLANING THE CYLINDERS OF A VAUCLAIN COMPOUND.

With the keen competition of today, in order that a manager may manufacture goods more cheaply than his competitor, he must have men in his employ of the best intellect, of the greatest industry and persistence, and loyal to him and to the business he represents. What better method can be adopted to secure these results than by training young men with a view of developing the very qualities that you desire?

Many of the young men will leave, but they will always look back to the works as to their home, and by their accomplishments will reflect credit on the works which trained them.

THE GREAT NORTHERN AND CITY RAILWAY—LONDON'S LATEST "TUBE."

By Herbert C. Fyfe.

A short time since—in December, 1903—we published an account of the Metropolitan Railway of Paris. In view of the stimulation of interest in rapid transit which will attend the approaching opening of the New York Underground (destined probably to be one of the busiest lines in the world) we have arranged to bring out during the summer illustrated descriptions of three great city systems—the London tube, the Berlin combined overhead and underground, and the New York subway. To this first of the group a sad interest is attached by the very recent death of the author, leaving this last work perhaps somewhat less finished than it might have been had he lived to revise and supplement it on its way through the press.—The Editors.

SINCE the opening of the first London "Tube" railway—the city and South London—in November 1890, many important improvements in this branch of engineering have taken place.

Four tube railways in the metropolis are open, and three more are now in various stages of construction; it may be of interest to point out the general distinction between this type and the "cut and cover" or other subways of New York, Boston, and the cities of the Continent, and the ways in which the newest tube differs from the three earlier lines in the London clay.

The Great Northern and City Railway will eventually extend from Finsbury Park to Lothbury, a distance of 3¾ miles. The Finsbury Park and Moorgate Street section has recently been opened for public service. The line is of peculiar interest in that its tunnels are of greater diameter than those of any tube heretofore built; that for the first time the "composite" tunnel has been employed; that the ventilation is much better, the coaches wider and the fire precautions greater than in any tube railway previously constructed. Again, two collector rails are supplied for the first time on any London railway. The sizes of the various London tunnels are shown in the following table:—

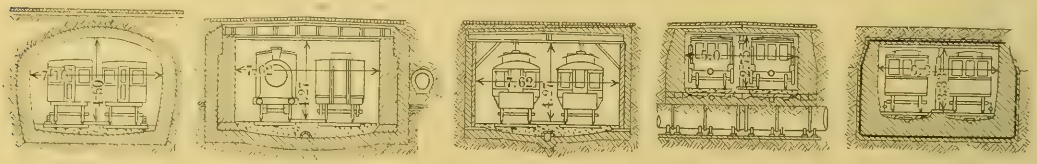
Tube.	*Internal Diameter of Tunnels.*
City and South London	10 feet 6 inches
Central London	11 " 6 "
Waterloo and City	12 "
Great Northern and City	16 "
Waterloo and Baker Street	12 "
Charing Cross and Hampstead	12 feet 9 inches
Great Northern and Brompton	12 " 9 "
Metropolitan District	25 feet

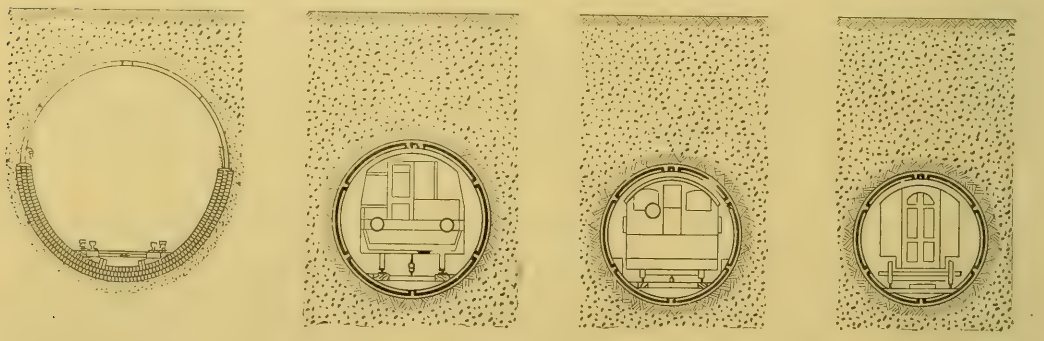
TUNNELS AT DRAYTON PARK, WHERE THE LINE OF THE GREAT NORTHERN & CITY RAILWAY COMES TO THE SURFACE.

It is interesting to note that when the Great Northern and City scheme came before the joint committee of the two Houses presided over by Mr. Standfield in 1892, the promoters were proposing to carry forward the ordinary surface Great Northern trains from Finsbury Park to Moorgate Street in the tube. At this time it was considered advisable that no new tube should be sanctioned unless its dimensions allowed the passage of main-line rolling stock. The tunnels of the Great Northern and City Railway are amply sufficient for the standard main-line carriages of the Great Northern Railway, but the promoters have abandoned their original idea and have made the terminal at Finsbury Park, 50 feet below the Great Northern metals.

Ventilation.—The wide tunnels of the Great Northern and City Railway should do much to render the air more pleasant than it is on the tubes now open. The question of ventilation has been much to the fore of late.

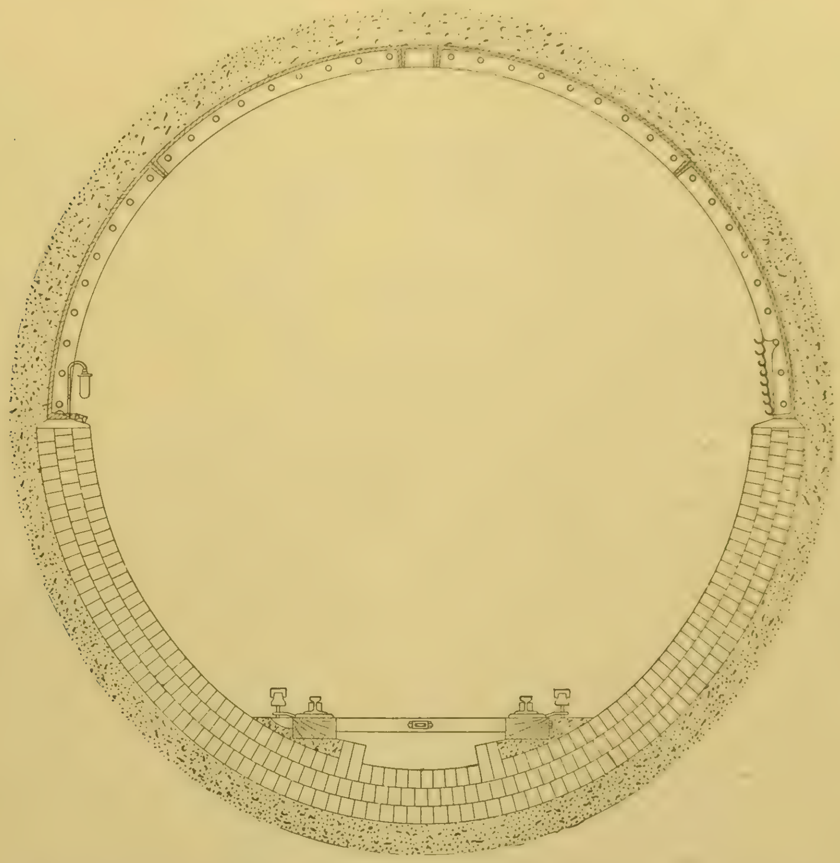
The public health committee of the London County Council has recently reported on the condition of the atmosphere of the Central London Railway, while others have at various times submitted it to be analysed. While these reports do not give cause for much anxiety, it is evident that something might be done to make the air more pleasant and to get rid of the peculiarly sickening atmosphere which encounters the traveller. The Central London Railway Company are establishing a huge electrical fan at Shepherd's Bush, which they expect will exhaust all the foul air in the tunnels in a very short space of time. At Bond Street station a powerful fan has lately been placed at the base of the lift shaft, which under ordinary pressure removes the vitiated atmosphere from the tunnels, fresh air taking its place at the various inlets. This fan is 48 inches in diameter and is electrically driven; it displaces 30,000 cubic feet of air per minute, and is capable of entirely exhausting the tunnels in a fraction over 3 minutes. The fan is worked every night after service hours.


Paris Glasgow Boston Budapest Berlin


Gt. Northern and City, 3.5 miles, diam. 16 ft. Waterloo and City, 1.5 miles, diam. 12 ft. Central London 6.5 miles, diam. 11 ft. 6 in. City, and South London, 6 miles, diam. 10 ft. 6 in.

THE UPPER LINE ILLUSTRATES SOME OF THE MORE IMPORTANT CUT AND COVER TUNNELS; THE LOWER, THE PRINCIPAL LONDON "TUBES."

The Composite Tunnel.—For the first time in the history of tube construction, the tunnels on the Great Northern and City Railway are of "composite" construction. So far all have been made of cast iron; but in the present case Mr. E. W. Moir, M. Inst. C. E., has devised a "composite" tunnel, viz., cast iron and brick, from which great things are expected, as it is believed that it will greatly diminish noise and vibration and will give a more substantial and a less elastic construction and consequently less vibration than is found in the other tubes. The multiple-unit system of traction which is being adopted on all electrical railways—whether underground or on the surface—will of course do much towards diminishing vibration. Originally, on the Central London Railway, electric locomotives were used. These brought about vibration which was felt in houses above the tube, but the locomotives have been superseded by motor and trailer cars. The City and South London is now the only tube which still retains its electric locomotives.



16-FOOT COMPOSITE TUNNEL, GREAT NORTHERN & CITY RAILWAY.

In the first part of the work executed, the tunnels were lined with iron, built up in segments 1-inch thick, with eight segments to the circle. These segments are 20 inches broad, measured in the direction of the length of the tube, and are bolted together through their inwardly projecting flanges by five 1-inch bolts on the sides and three 1-inch bolts on the ends. A key plate 12 inches wide is used at the top, and the space between the segments and the clay wall is filled in with lime blown in while in the liquid form, on the system devised by the late James Greathead, inventor of the Greathead shield.

After about 4,000 feet in each tunnel had been constructed in this way, Mr. Moir, of Messrs. S. Pearson and Son, Ltd., the contractors, decided to adopt the "composite" system, in which only the top half is lined with cast iron, the lower half being built in with a special brickwork in Brindle brick. A cast-iron bearer plate is placed on the line of contact between the iron lining and the brickwork, so

AN INTERIOR VIEW OF THE TUNNEL, SHOWING A STATION PLATFORM.

as to distribute the pressure evenly over the section face of the brick, the brickwork is 15 inches thick and the bricks are capable of sustaining a pressure of 400 tons to the square foot.

Vibration.—The Board of Trade committee which enquired lately into tube vibration, called attention to the fact that in consequence of the small diameter of the tunnels on the Central London Railway (11 feet 6 inches), the fit was too close, and the consequent pressure in front of the trains necessitated greater power to overcome it.

The original "gearless" electric engines on the Central London Railway weighed 44 tons, the newer geared pattern 33 tons, while the motor cars now in use weigh only 20 tons.

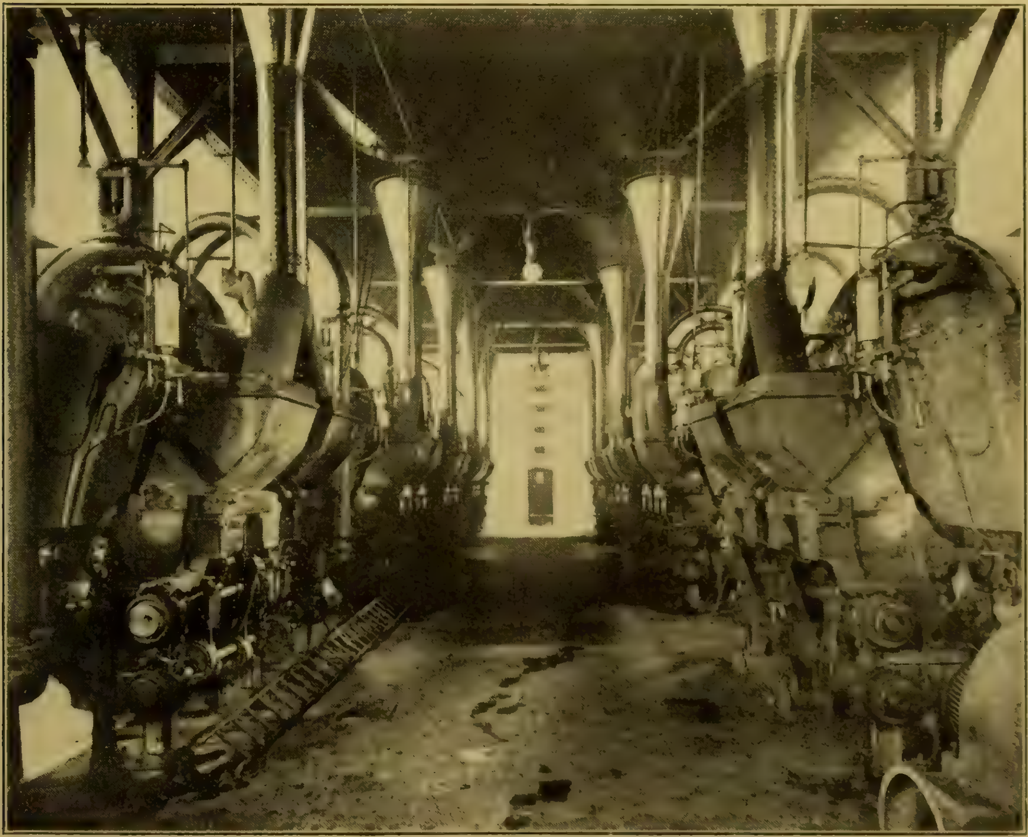
Station Tunnels.—The running tunnel is throughout 16 feet in diameter, but the station tunnels are bigger. The biggest are at Moorgate Street, viz., 23 feet in diameter and 475 feet long. All the other station tunnels are 21 feet in diameter and 420 feet long.

The Shields.—So far back as the year 1818, Sir Mark Isambard Brunel, when engaged on the construction of the old Thames tunnel between Rotherhithe and Wapping, designed "shields" in order to get rid of the timbering then considered necessary in tunnelling.

Brunel's shield was of iron and it was pushed forward by means of screw jacks; platforms were provided on which the men could walk at different levels; the face and roof were supported during excavation, and the brickwork of the tunnel was built up in the rear.

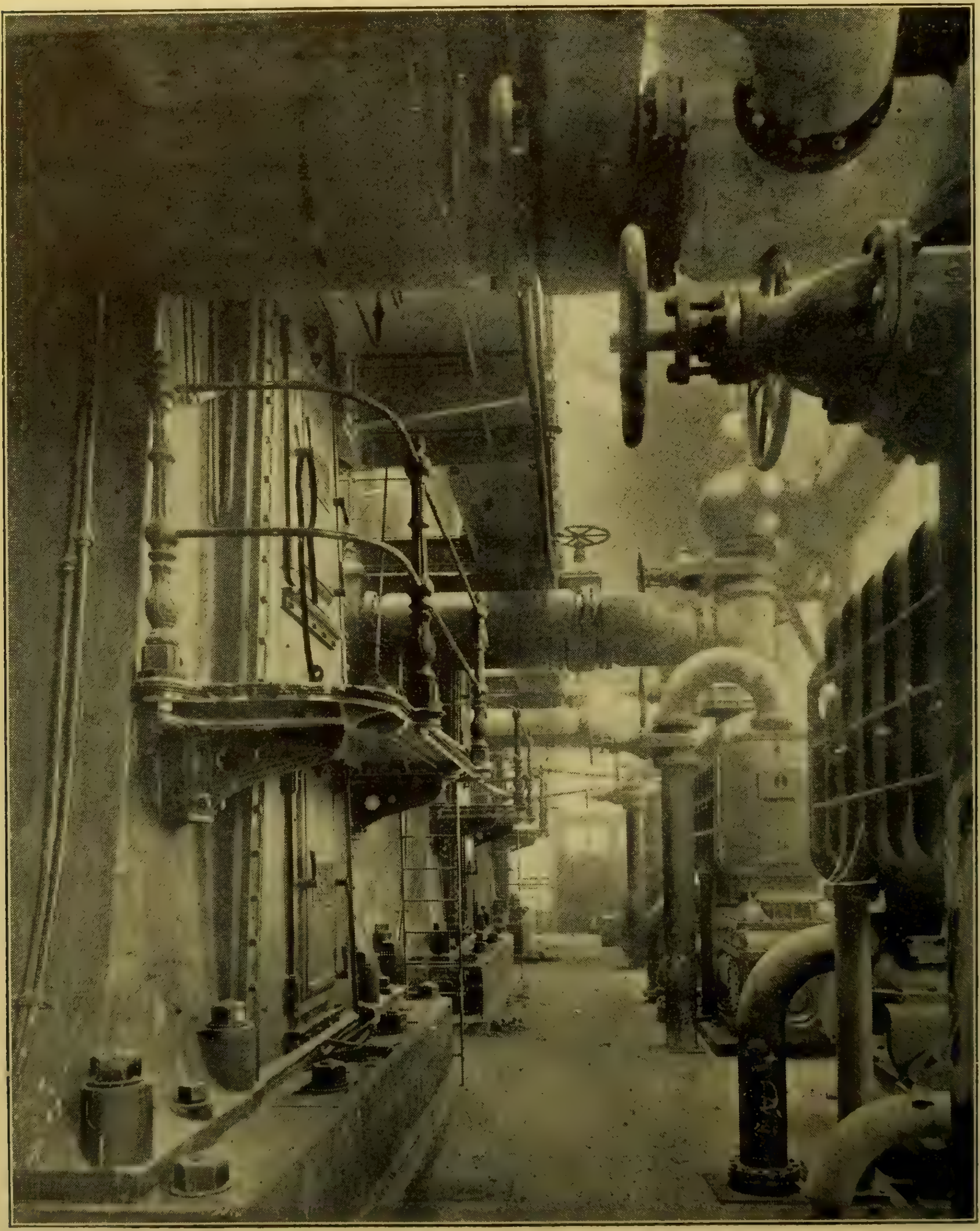
The modern shield is worked on much the same principle, but of course it is a much more powerful and effective appliance. Its advantages are that the proper size and shape of excavation are secured and that the workmen are never exposed to the risk of an unsupported roof. The shields now used in tube railway construction are structures of steel, cylindrical in shape, provided with cutting edges in front. They are forced forward by powerful hydraulic rams, and are made in sections which are taken down the shafts and put together at the bottom.

The 17-foot 3-inch Shields.—The shields used for making the 16-foot running tunnels on the Great Northern and City Railway are 17 feet 3 inches in diameter, and are noteworthy in that the hydraulic pressure used (over 2½ tons per square inch) was greater and the rams were more numerous, more powerful, and of considerably larger diameter than hitherto used in tube construction.



BOILER ROOM, SHOWING THE VICARS MECHANICAL STOKERS.

The cylindrical shell of the 17-foot 3-inch shield was composed of half-inch steel plates rivetted together, with flush heads outside. It was built in six sections; its length from cutting edge to rear is 8 feet 9 inches. Round the cylindrical front are mounted ten heavy cast-steel cutting edges, and one horizontal and two vertical bulkheads, reinforced by angle irons, serve to stiffen the structure. The horizontal bulkhead projects about 6 inches beyond the cutting edge and so helps to prevent any subsidence of the clay. The shield is



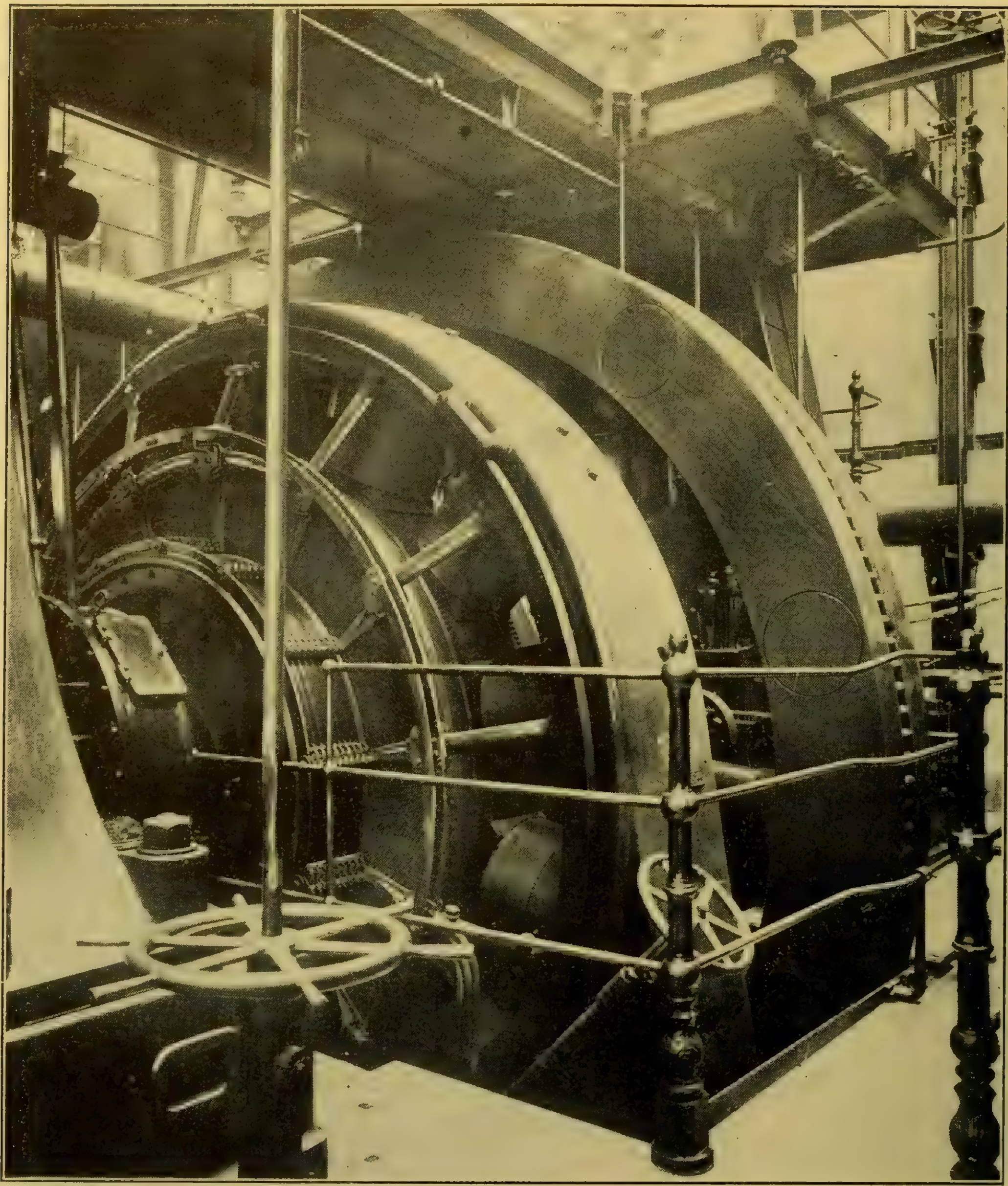
POWER HOUSE, GREAT NORTHERN & CITY RAILWAY.

divided into six compartments, each 4-feet wide, in each of which a man works on the face of the clay.

It is pushed forward by sixteen hydraulic rams or jacks, each bored out of solid ingot steel and 7 inches in diameter. The pressure has been as great as 2¾ tons to the square inch; the rams exert their pressure directly on the back of the cutting-edge castings, and the purchase is taken off the edge of the erected tunnel segments nearest the shield. Before each "shove" the men excavate the clay with pick axes and cut grooves in the face to a depth of some 18 inches; the shield is then driven forward, and the excavated material is carried away on trucks hauled by ponies and sent up the nearest shaft. The jacks are connected up the back to the hydraulic service, and the controlling valves are worked from one point on the back.

THE MAIN SWITCHBOARD IN THE POWER STATION.

Station Shields.—The station shields are of two types. In the case of the Moorgate Street station they are 24 feet 8½ inches in diameter and 9 feet 6 inches in length, with two vertical and two horizontal bulkheads, giving nine working compartments, and are provided with twenty-four 8-inch hydraulic rams. The shields used for other stations are 22 feet 10 inches in diameter.



ONE OF THE LARGE GENERATING UNITS IN THE POWER STATION.

The London Clay.—In making the Central London Railway the London clay was met with 29⅛ feet below the surface. It ran almost without a break between the Bank and Shepherd's Bush, the only gap being at a point between Red Lion Street and Berner's Street, where the Woolwich and Reading strata cropped up, consisting of hard red streaky clay, beds of white sand, and limestone rock.

The depth of the tubes varies considerably. At the Bank the Central London Railway is 65 feet below the road; at Notting Hill Gate 100 feet. In some places the Charing Cross and Hampstead tube will be from 120 to 216 feet below the surface.

The Erector.—A hydraulic crane is employed for placing the cast-iron segments of the tunnel lining in position. In the case of the 16-feet tunnels, one erector was used for erecting the cast-iron segments of the rings; but in the case of the larger shields two were used.

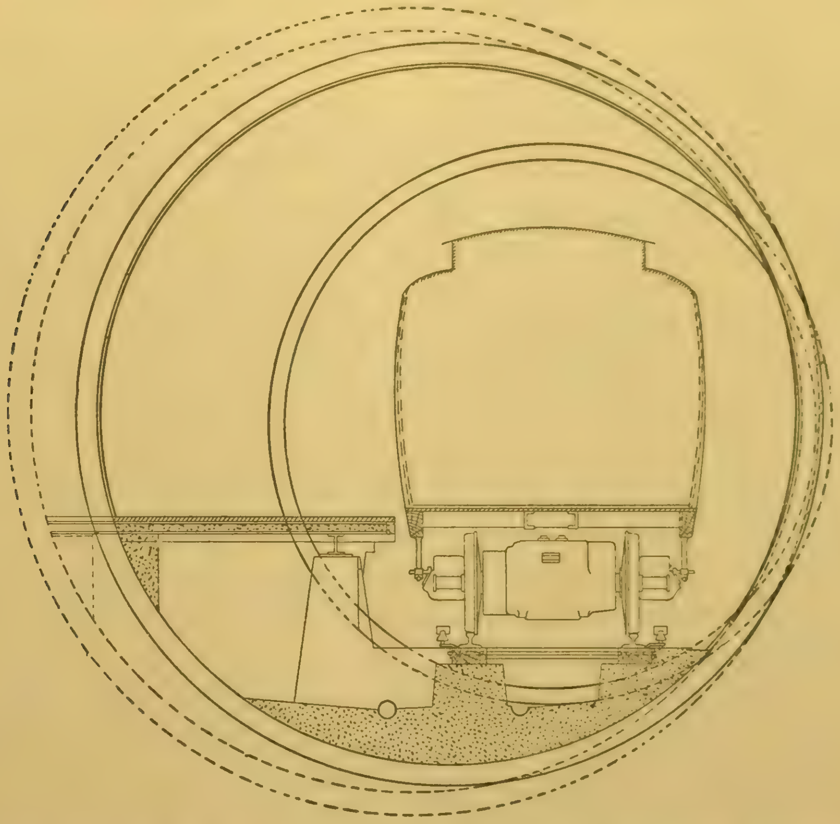
The erector is attached to the back of the shield at the centre, so that its arm can sweep the whole periphery of the circle, whilst there is also an extending and contracting motion radially; in the case of the smaller one the rotating motion is worked by means of a rack and

HUNT COAL CONVEYOR, OPERATED BY BRITISH-THOMSON-HOUSTON MOTOR.

CANAL AT THE POWER HOUSE; HERE COAL IS UNLOADED BY MACHINERY AND DELIVERED TO HUNT CONVEYORS, WHICH ON THEIR RETURN CARRY THE ASHES BACK AND UNLOAD THEM.

pinion, the rack being moved to and fro by means of hydraulic rams with stationary cylinders. The rack rotates the pinion about the main trunnion, and the latter is extended forward so as to form a box in which the extended arm slides, the extending motion being produced by another ram and cylinder bolted to the box.

How the Segments Are Erected.—The segments which go to make up the ring of the tunnel are built up within the tail of the shield, which always overlaps by 1 foot 8 inches, or one cast-iron ring, the last completed portion of the tunnel, so that the clay has no chance of pushing through into the tube. Eight segments and one key piece go to make up one complete ring, and when these have been laid against the skin of the shield and bolted together, the shield moves forward, leaving an annular vacuity 4 inches in width between the back of the plates and the natural ground. This space is made solid by the injection of a grout under pneumatic pressure.



TRANSVERSE SECTION OF 16, 21, AND 23-FOOT TUNNELS, SHOWING ROLLING STOCK, PLATFORMS, AND PERMANENT WAY, GREAT NORTHERN & CITY RAILWAY.

Rolling Stock.—The multiple-unit system will of course be employed; each train will consist of seven cars, three of which will be motors and four trailers. It is proposed to run a three-minute service of seven-coach trains, and the single journey will be made in some 13½ minutes, including three intermediate stops of 20 seconds each. The acceleration will be about 2 feet per second per second. Each train when fully loaded will weigh 200 tons, and each will seat about 500 persons. Each motor car is fitted with two 125-horse-power motors, and each can seat 58 passengers; the trailers accommodate 62. The maximum speed will be 33 miles an hour.

The cars are 49 feet 6 inches long and 9 feet 4 inches wide; fire-proof compartments are fitted at the end of the motor cars for the reception of the electrical equipments. The trains are equipped with the Westinghouse quick-action brake. The motors are being supplied by the British-Thomson-Houston Company, and the British-Thomson-Houston master-control system will be used; they weigh 4,280 pounds and are rated at 125 horse-power. The current is picked up by a shoe attachment from a third positive rail, the return being through a fourth negative rail; one of these insulated rails is placed outside of each of the track rails; they are made of low-carbon steel, having a very low electrical resistance.

The Power House.—The power house is situated on the banks of the Regent's Canal. The ground area of the site is about 22,500 square feet; the main engine plant consists of four Musgrave vertical cross-compound condensing engines, each of 1,250 indicated horse-power, and there are four main continuous-current generators of the standard British-Thomson-Houston type, coupled to the engine shafts and placed between the high-pressure and the low-pressure cylinders. Their nominal rating is 800 kilowatts each at 575 volts. There are besides auxiliary steam engines and auxiliary generators for the supply of power for lighting, etc., when it is not convenient to take power from the main generators for this purpose.

The plant at this station is sufficient to run the whole line, to work the passenger lifts at Essex Road and Finsbury Pavement stations, and to light the whole railway.

The methods of coal handling and storage are interesting. Coal is brought by the canal and is hoisted by a 5-ton electric crane into a coal conveyor; the upper buckets deliver the coal to the coal bunker and the lower returning buckets are utilised for the removal of ashes, which by means of a shoot are delivered into canal barges. From the bunker the coal is fed by shoots into mechanical stokers of the Vicars type; the stokers are driven by two electric motors, placed at the end of the boiler house, each capable of driving the whole of the stokers.

As to the progress of the work, a maximum speed has been attained of erecting 44 rings of the segments, completely bolted together and "grouted," during the week of 5½ days. The average is 35 to 40 rings a week. At each forward move some 20 inches progress is made through the clay, and the average daily distance traversed by the shield is 8 to 10 feet.

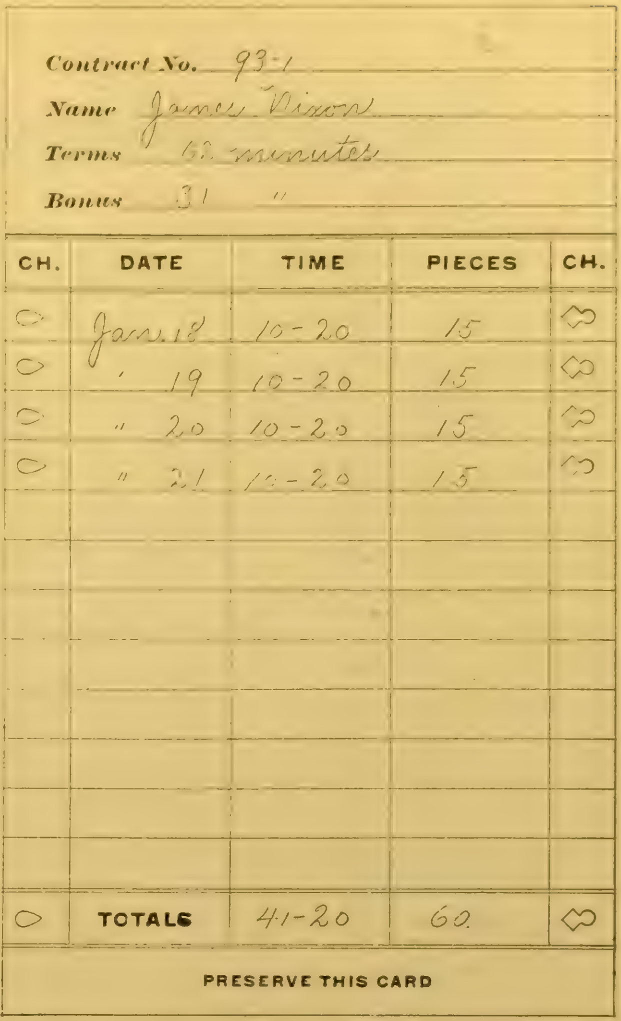
THE PREMIUM PLAN OF WAGE PAYMENT IN A REPAIR SHOP.

By Albert W. Thompson.

IN the preceding issue of this Magazine I described the shop-statistics and cost-keeping system in use in the shops of the Amoskeag Manufacturing Company, in which the principal business is repairs and the work presents a great variety of detail. It remains to review the methods which have been used in adapting the premium plan in the same works.

Bonus and premium systems of rewarding labor, while they attain a high state of efficiency in manufacturing shops, are not readily adaptable to ordinary repair work; and therefore the ordinary or day-rate system is used in this shop. Many cases occur, however, in building new machinery or in extensive alteration work, where duplicate parts are produced in quantity sufficient to offer good opportunity to apply the premium system, and it has gradually been introduced without in any way disturbing the prevailing system, and with very good results. To illustrate the application to alteration work, let us suppose that several hundred ring-spinning frames in one of the large mills are to be equipped with an improved type of spindle, necessitating changes in various parts of the frames, such as lowering the spindle rails, putting in new lifter rods, hangers, etc. The shop foreman who has charge of all spinning repairs organizes an adequate gang of men under a capable sub-foreman, after getting on hand enough new parts to insure continuity of work, and commences the change, giving the work the closest attention possible for a few days. At the end of a week the men are well organized and their capacity can be pretty closely gauged. Let us suppose that ten frames have been changed. Allowing for "hitches" incidental to the start, we estimate that at least twelve frames can be changed per week under ordinary circumstances, i. e., day-rate. We offer the men, then, "half time extra on all frames above twelve per week." This means that they are considered able to do twelve frames per week, or two per day, equivalent to one half a day per frame, and that for all accomplished above that rate they are entitled to one half the time saved, or a quarter of a day's pay for each additional frame. This method has always given good results, as the estimates have been fairly made, and the men in consequence do their best and earn good wages. The men practically organize themselves, and if there are any laggards in the gang they are at once detected and replaced by better men. Under this system there is no opportunity for slighting the work in the effort to increase earnings, for such gangs are always managed by a reliable sub-foreman who is held responsible for the work and who permits no shirking. Cut-downs have never been made on the original rates, as experience proves that the first few days' work forms a reliable basis for fair estimates.

In the machine shop, where a man is to be started out on premium work, two different methods of estimating are used. If the operations are short and simple, the foreman or second hand finishes a few pieces, timing his own performances. If a relatively long time is required for each piece the foreman or second hand determines the feeds and speeds to be used, and a man is at once started on the work. He is watched by the foreman or second hand with sufficient care to detect any hanging back, which, if it is suspected, is liberally discounted in the estimate which is made with the result of his first few hours' work as a basis. As the rate finally applied dates from the time when the work commenced, and as most of these jobs last for a few days only, the workman himself is usually the principal loser by any attempt at deceit, since he loses production and in all probability has his rate discounted. When the work is to be of long duration the importance of accurate estimating is increased, and the former of the above methods is used. If improved tools or jigs which make an increased output possible, are introduced during the course of the work, the rate is modified, but only to a point which allows the workmen to profit by it to a reasonable extent, thus removing any tendency of the workmen to oppose improvements and encouraging them to suggest them. Cut-downs are almost never made, for although all contracts are made for one payment only, it is cansidered better policy to allow a man to earn a high compensation for a few days than to run the risk of arousing the spirit of dissatisfaction and sullen opposition which is sure to follow the practice of cutting rates. When machinery operations are relatively brief and handling operations relatively long, the bonus rate is usually fixed at about one half of the production rate, since it is in these cases that the greatest gains are made in production, simply by increased attention to business. If, on the other hand, the machinery operations are relatively long and handling relatively short, the bonus rate is increased, as small gains represent more effort than in the former case. It should be noted that this method offsets to a certain extent the danger of too lenient estimates, as in cases where the estimate is based on the performance of a man who has handled his work slowly, it is difficult for him to increase his output to a point where his earnings become unreasonably large, on account of the low bonus rate.



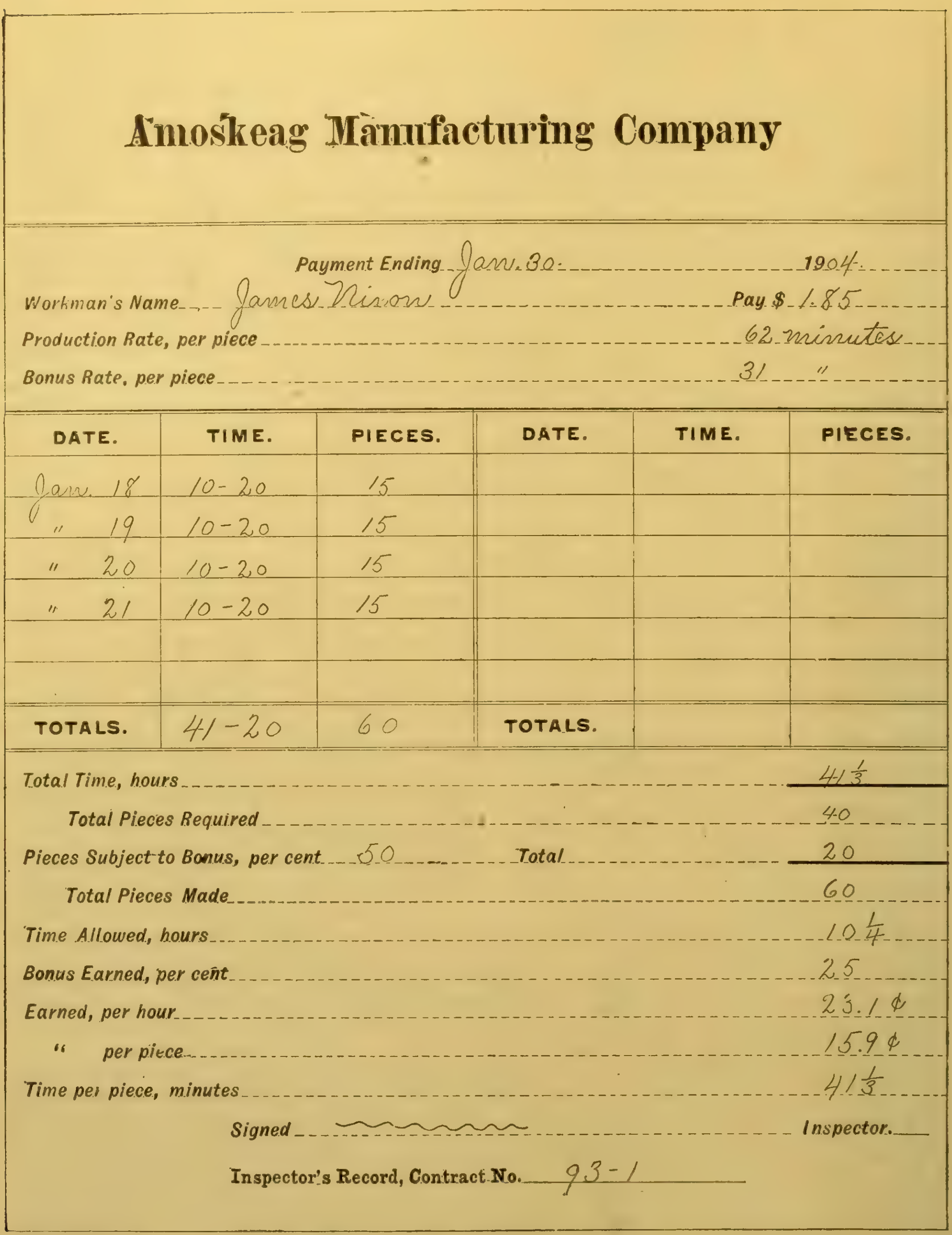
Contract No. 93-1
Name James Dixon
Terms 62 minutes
Bonus 31 "

CH.	DATE	TIME	PIECES	CH.
✓	Jan. 18	10-20	15	✓
✓	" 19	10-20	15	✓
✓	" 20	10-20	15	✓
✓	" 21	10-20	15	✓
✓	TOTALS	41-20	60	✓

PRESERVE THIS CARD

FIG. 11. ORIGINAL CONTRACT RECORD.
The original card is 3½ inches wide and 5¾ inches high.

Figures 11, 12 and 13 show the forms used for the original contract record, the inspector's record, and the workman's contract card. The clerk who inspects all premium work also assists the foremen in making and recording contracts, all records of which are filed in the shop office on the day when they are made, as shown in Figure 11. The production rate is the time, usually stated in minutes per piece, which the workman must excel before any premium is earned. The bonus or premium rate is the premium earned, also stated in minutes per piece, on each piece produced above the number called for by the production rate. Where a contract is made and work begun the foreman gives the workman his contract card, upon which are entered the terms of the contract, its number, and the time when work begins. The workman keeps his own count of work produced and enters the time worked on this card and also on his regular time card. Each morning the inspector—who has previously inserted an inspector's record (Figure 11) in the record book which he carries, each sheet of which corresponds to a contract in operation—visits all men employed on contract



Amoskeag Manufacturing Company

Payment Ending Jan. 30. 1904.

Workman's Name James Nixon Pay $ 1.85

Production Rate, per piece 62 minutes

Bonus Rate, per piece 31 "

DATE.	TIME.	PIECES.	DATE.	TIME.	PIECES.
Jan. 18	10-20	15			
" 19	10-20	15			
" 20	10-20	15			
" 21	10-20	15			
TOTALS.	41-20	60	TOTALS.		

Total Time, hours 41⅓

Total Pieces Required 40

Pieces Subject to Bonus, per cent 50 Total 20

Total Pieces Made 60

Time Allowed, hours 10¼

Bonus Earned, per cent 25

Earned, per hour 23.1 ¢

" per piece 15.9 ¢

Time per piece, minutes 41⅓

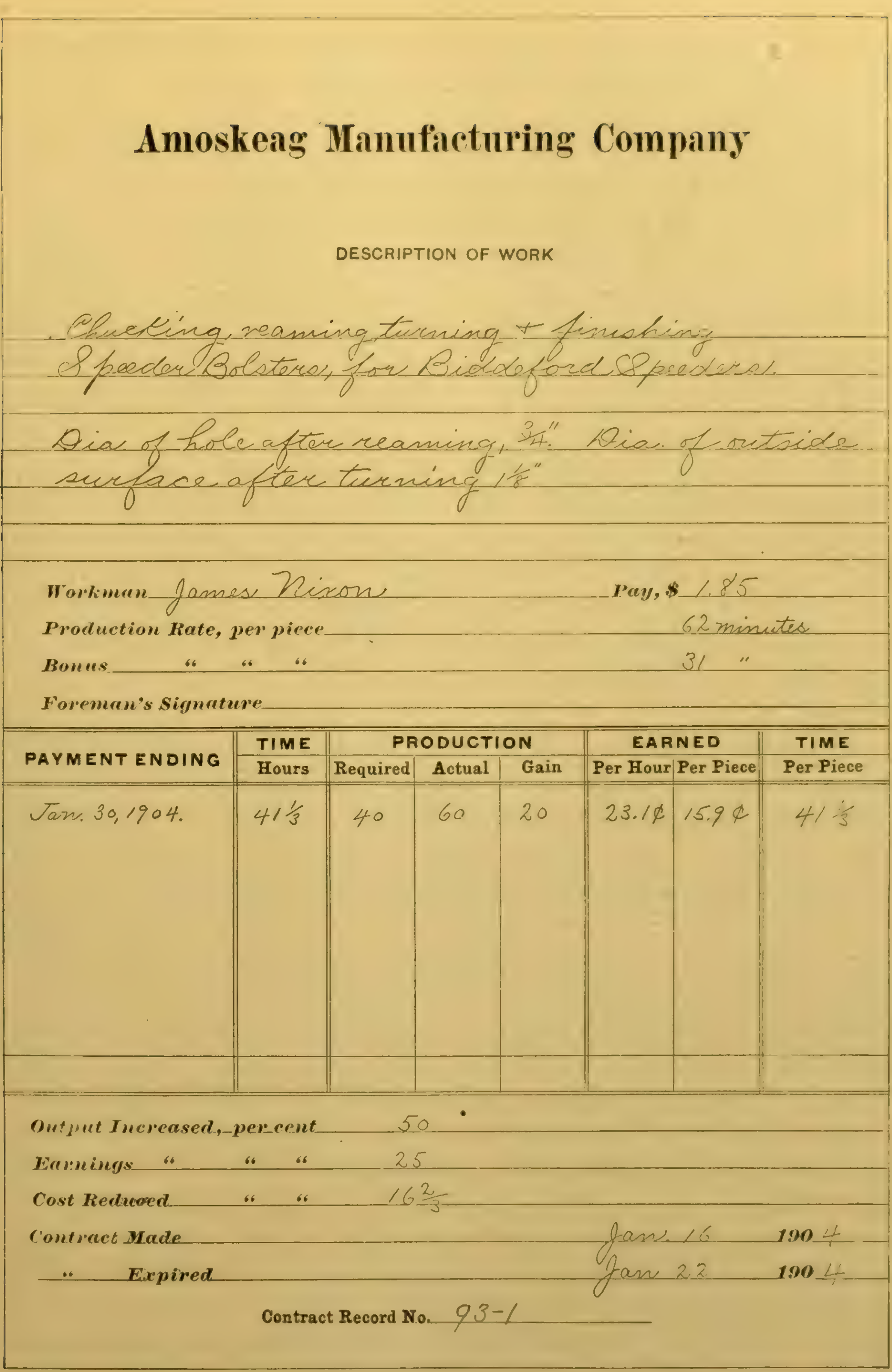
Signed Inspector.

Inspector's Record, Contract No. 93-1

FIG. 12. INSPECTOR'S RECORD.

The original is 5½ inches wide and 8¼ inches high.

work, counts and inspects their work and cards, and enters results on his record sheets. He is followed by a man who removes all work produced to the painting floor or to the next department where work is due. In cases where successive operations are required in the same department, the work is required by be prick-punched or stamped after counting, thus preventing recounting. After visiting the men the in-



Amoskeag Manufacturing Company

DESCRIPTION OF WORK

Chucking, reaming, turning + finishing Speeder Bolsters, for Biddeford Speeders.

Dia. of hole after reaming, ¾". Dia. of outside surface after turning 1⅛"

Workman James Nixon *Pay, $* 1.85

Production Rate, per piece 62 minutes

Bonus " " " 31 "

Foreman's Signature

PAYMENT ENDING	TIME	PRODUCTION			EARNED		TIME
	Hours	Required	Actual	Gain	Per Hour	Per Piece	Per Piece
Jan. 30, 1904.	41⅓	40	60	20	23.1¢	15.9¢	41⅓

Output Increased, per cent 50

Earnings " " " 25

Cost Reduced " " 16⅔

Contract Made Jan. 16 190 4

" *Expired* Jan 22 190 4

Contract Record No. 93-1

FIG. 13. WORKMAN'S CONTRACT RECORD CARD.

The original form is 5½ inches wide and 10¼ inches high.

spector visits the foreman, who verifies his time records. The workman's card is punched by the inspector opposite the count entry, and by the foreman (to whom all cards are handed at night) opposite the time entry, which must check with the foreman's record. The records cannot be altered to meet any claims made after cards are punched.

At the close of a payment the inspector computes the time allowance earned by each workman, enters it on the sheet in the manner shown, and turns the sheets over to the pay-roll clerk, who adds the allowed time to the working time on the pay roll. The sheets are then returned to the inspector, who fills out the remaining blanks on the sheet and transfers the results to the original record, which is kept on an indexed file for reference.

The clerical work involved by the systems above described, including the cost-keeping and shop-statistics systems described in the preceding article last May, is readily performed by three clerks, who also have other duties not touched upon here. It is probable, however, that another clerk will soon be required, as the increasing use of the premium system will soon call for the undivided attention of one man for estimating and inspecting and the clerical work incident thereto.

In closing I would say, in regard to the cost-keeping methods, that they are here described without claiming for them any merit but that of flexibility and adaptability to the peculiar conditions for which they were designed. They would suffer unjustly by comparison with the highly developed systems in use in many manufacturing shops, where inflexibility is the great desideratum. The same statement holds true in regard to the method of applying the premium system. In a shop organized on the lines here obtaining the personal equation of the foreman is an important factor in the success of such methods, and his influence and co-operation are to be sought rather than avoided. With less than fifty contracts in operation at one time this system works smoothly, but attempted on a large scale it would soon become troublesome and a different and more scientific method of estimation would become an imperative necessity. At least, this method is a simple means for the tentative introduction of the premium system without disturbing existing conditions, and will serve until the volume of work outgrows the limited capacity to which it is restricted by its characteristics. In common with all such systems, it possesses the merit of rewarding the workman for what he does accomplish, rather than for what he is expected to accomplish.

THE REDUCTION OF FIRE HAZARDS IN ELECTRIC PLANTS

By Howard S. Knowlton.

IT is probable that the loss of property by fire this year in the United States and Canada will amount to more than two hundred million dollars. The great Baltimore conflagration and the Toronto and Rochester fires are the principal bases of this prediction. Among all the vital problems confronting civilization, it is safe to say that scarcely any single question affects the material welfare of humanity more closely than does the elimination or reduction of this fearful source of waste. Over and above any valuations of property loss stands the annual sacrifice of human life.

Industrial processes involving heat, light, and power cannot be divorced from all hazards of fire. This being so, the duty of every engineer is plainly the reduction of such hazards to the lowest possible amount. The mechanical phases of electrical construction are today greatly superior in point of workmanship, thoroughness, and security to the work of ten years ago. This applies, of course, to new installations, in the main. A great deal more, however, remains to be done along the line of diminishing the fire risk. It is surprising how many defective practices will stare one in the face on a tour of inspection.

The fire problem divides itself naturally into two parts:—precautions against the occurrence of fire, and the means of extinguishing the flames when once a blaze has started. It is of literally tremendous importance that the life of the most insignificant fire should be measured in seconds, and still more imperative is it that as far as human knowledge can insure, there shall be no combination of materials and circumstances capable of causing any fire whatever. The solution of the problem is, then, a matter of details.

Electric plants, like all other types of industrial buildings, call for some form of concrete, brick, and steel construction, with a conspicuous absence of wooden walls and beams, if the greatest security against external or internal conflagrations is to be attained. As an alternative, the "mill" or "slow-burning" construction is sometimes necessary, the use of wood being essential in some parts of the country. The exposure of the building to adjoining structures is also a matter of serious consideration. The use of fire shutters on all windows at the rear and sides which in any case are likely to be attacked by flames cannot be too strongly urged. Due allowance should be made for the effect of heavy gales of wind in considering the risk presented by buildings even two or three hundred feet away. Usually it will be impracticable, for æsthetic reasons, to place shutters on the front windows of plants, and often the same restriction applies to certain side windows also. An effective substitute for shutters is found in the use of wired glass windows set in metal casings. Even these windows are objectionable in many offices, on account of their non-transparency, although their diffusion properties are excellent. As a last resort, asbestos roller curtains may be fitted to the inside of the windows. These should fit the casing tightly when drawn down, and should always be provided with eyelets so that they may be fastened down at night or in times of emergency. Wooden window casings are not advisable. Every side of the electric plant should be gone over in this connection, and the roof, as well. Often a pent house or roof shack will be found to be composed of the most flimsy and inflammable material, with plain glass windows, wooden doors and casings, even though the sides may be lined with tin or sheet iron. It is a good plan to place fire shutters or wired glass in such instances where the risk is apparent. There is little excuse for the use of plain glass in roof windows and doors. Another precaution which is at times invaluable on the roof is a water faucet with a screw thread cut at its end for the reception of a hose coupling. In case sparks and brands from a nearby fire are blown upon the roof by the wind, the advantages of such a water supply are great. Some means should be provided for closing all ventilating apertures in walls which are exposed to the direct onslaught of fire. Monitors should preferably be of wired glass, as this material is practically as effective when broken in fragments as when solid, its power of holding together is so noteworthy. Shutters ought not to be fastened tightly to the walls with stout wire, as this greatly delays their closing at a time when minutes are precious, nor should they be constructed with more seams than are absolutely necessary, the experience of the Baltimore fire showing the unreliability of shutters abounding in seams. Gravel and slate roofs should always have the preference over wooden construction.

The yard and premises surrounding electric plants are often sources of considerable risk. It would seem unnecessary to point out the danger of throwing hot ashes into wooden barrels, casting refuse paper upon ash piles, and allowing miscellaneous rubbish to accumulate in sheds and store houses; and yet this condition is in existence in countless localities the country over. The storage of gasoline is another fruitful source of fire. It is better to keep but a gallon or two around the premises at any one time, and this ought always to be held in a fire-proof can, properly marked, and fitted with a tight stop cock and cover. In every instance the oil can is safer outside the main building than within it.

In almost all telephone and telegraph offices, and in many electric-lighting and railway plants located in regions traversed by high-potential transmission circuits, the chances of fire through the crossing of low and high-voltage wires are so great as to warrant a most careful investigation of the situation by a skilled engineer. This is an outcome of the rapid multiplication of power circuits throughout the country in the development of the long-distance transmission of electrical energy at potentials ranging from 5,000 to 60,000 volts. Special overhead construction for the prevention of such crossings is now being installed at many danger points, but the work has hardly been begun as yet. A high-tension "cross" on a low-tension line may easily start fires at many widely scattered points, to say nothing of the risk to human life. Ordinary protective devices in the way of fuses, automatic cutouts, and circuit breakers are usually effective up to 5,000 volts, but beyond this potential the only safe course appears to be the absolute prevention of any contact whatever between circuits which literally carry "chained lightning" and those of lower pressure. The latest rules of the National Board of Fire Underwriters are suggestive in detail as to how to avoid these serious dangers.

The question of a water supply on each side of the building is quite as important on the ground level as on the top of the roof. The availability of a fire or garden hose long enough to reach the most distant point on the premises from every supply faucet is pre-supposed. This hose should preferably be kept on a light reel which can be easily rolled about, and should not be coiled up in some dark corner of the basement where heat or dampness will cause rapid deterioration.

If hydrants are set in the yards of plants for the protection of store houses, oil houses, etc., they should be provided with a valve below the frost line in the earth, as well as an independent outside valve on each of the hose connections.

The location of the nearest fire-alarm box should be familiar to every employee, and the practice of installing a special alarm box at the electric plant itself is worthy of imitation.

Turning to the interior of plants, we may profitably consider some of the more frequent causes of fires in the attempt to examine the means of prevention and extinguishment. It is impossible to separate these causes clearly, as many of them run more or less together. Nor can a complete list be easily prepared, but it is not difficult to present a fairly representative and suggestive summary:—

Table of Causes of Fire in Electric Plants.

Accumulation of combustible material such as waste, rags, paper, kindlings, shavings, greasy refuse, and dirt.

Spontaneous combustion of wet sawdust, rags, shavings, soot, coal, and decayed wood.

Explosion of gasoline, alcohol, kerosene, petroleum vapor, illuminating gas; ignition of oils; leakage of reservoirs, tanks, lanterns and pipes.

Incendiarism.

Boiler explosions; bursting of steam pipes; faulty chimney and flue construction; careless handling of ashes.

Overheated soldering torches; gas or electric heaters improperly supported on combustible bases; thawing out pipes; burning rubbish; swinging gas fixtures; absence of sheeting around stoves, hot pipes, etc.

Careless handling of matches; unsafe storage of matches; rats and matches; thoughtless throwing of cigars, pipe ashes, and cigarettes near or into sawdust spittoons, waste baskets, excelsior barrels, etc.; misuse of candles.

Belt friction, overheated bearings, stoves, pipes; heavy overloads on dynamos, motors, transformers, wiring and switchboard appliances.

Ignition or explosion of chemicals in work rooms; exhaustion of employees from overwork; boiling over of tar kettles; mixture of water with sulphuric acid in storage battery work; water coming in contact with lime in bulk.

Lightning.

Defective electric wiring and fixtures; contact of incandescent lamps with inflammable substances; grounds, short circuits, overloads, sparks from arc lamps, flashing at commutators; overheating of wires and cables.

High-potential crosses.

An examination of the foregoing causes of fire will inevitably lead to the conclusion that the greater proportion of them are preventable. Careless operation is at the bottom of most of the trouble. Unceasing vigilance of inspection is the price of security—in fact, the whole problem of fire prevention is largely one of keeping all possible hazards in mind, and watching all the dark nooks and corners.

The supply and maintenance of apparatus for the discovery and extinguishment of incipient fires deserve the closest attention. Inside an electric plant, water is of no value in putting out an electrical fire, and for this reason automatic sprinklers are undesirable. Extinguishers of the dry powder, chemical, or compressed-gas type are far more effective for all-around service. Fires caused by electric arcs are best beaten out by asbestos or woolen blankets, overcoats, towels, etc., or else quenched by the liberal use of sand. Tanks and pails intended for fire use only are liable to become empty, and changes in partitions, store rooms, shelves, and supplies are likely to prevent efficient fire fighting, unless the inspection is regularly kept up and the hazard constantly borne in mind. A daily examination of the condition of extinguishers, pails, pumps, valves, shutters, and alarm systems may not be necessary, but it is certainly unwise to let more than a week elapse between inspections. It pays to file written reports, discussing changes in the fire-fighting equipment of the plant; unusual conditions observed; date of refilling pails, replacing or recharging batteries; results of tests, etc. The responsibility of this work should be laid upon one employee alone, and his reports should receive the attention of the superintendent or manager and not be allowed to lapse into mere perfunctory records. Chemical extinguishers ought to be discharged and refilled at least once a year. Loose wiring and frayed insulation should be repaired as soon as discovered.

The entire wiring system ought to conform to the practice of the National Board of Fire Underwriters. Special care is necessary to avoid the overheating of circuits through inadequate design; the use of unapproved fittings; and contact of insulated wires with wood or metal work. Loose ends of circuits should be taped and placed out of harm's way. In all sorts of electric plants, incandescent-lamp cord is likely to be run anywhere and everywhere with the utmost carelessness, and this constitutes a hazard of no small importance. Electric heaters should never be left in circuit, by themselves, through the noon hour or at night.

Windows and doors in attics and lofts should be closed at all times when no one is present, and all doors in the path of strong drafts of air should preferably be covered with sheet iron or tin. In case of fire, doors dividing different parts of the plant should be closed at once to prevent the supply of air and check the spread of the flames. Doors between boiler and engine rooms, for example, which are hung on inclined tracks, should be examined frequently to see if they work properly, and when it is necessary to keep them open, the use of a fusible link is good practice. Doors leading to oil rooms are safer when closed. Oily waste should never be stored anywhere when in use except in fire-proof cans or boxes with self-closing covers. Buckets of sand with scoops, and fire extinguishers, should be placed in prominent positions throughout the plant, and not hidden away in closets, under stairways, etc.

Great confusion often arises in electric plants during fires through the station's being plunged into utter darkness by the failure of the lighting current. This is easily preventable by the use of either oil or candle lanterns, and it is the part of wisdom to provide such an alternative source of illumination in every plant. The water and gas supply, if a station is provided with the latter, ought to be equipped with valves at the entrance of the building.

An automatic fire alarm which will give warning of any unusual temperature rise beyond safe limits is a necessity in all plants which are divided into several rooms, such as telephone exchanges. Experts in fighting fires are unanimously agreed that the earliest stage of the flames is the time to put in the most effective work, and money spent for thermostat alarms is well invested. Simplicity in design and positive action are the desirable features of such apparatus. Even if a plant is constantly under the eyes of the operating force, it is a wise precaution to equip out of the way corners with some such device.

Gas engines should be fitted with automatic valves which will cut off the supply of fuel in case the engine comes to a stop, and the exhaust piping from such machines should be as free from bends as possible, and if it is not carried up special brick flues in the wall of the building, it should extend outside of the building and not discharge into a chimney. When this piping passes through wooden floors, partitions, or roofs, it should be furnished with ventilating thimbles. In order to avoid exposure to water damage, switchboard cables may be run at least four inches from the floor, and all plumbing pipes should be so installed that in case of leakage, water cannot reach any of the electrical apparatus or wires.

The entrance of very high potential wires into a power plant building or substation is a matter demanding the best engineering construction. Considerations of the striking distance of extreme voltages; possible obstructions due to animals, birds, or wind; glass thimbles, moisture and open air space, must all be carefully taken into account. Transformer connections, to be safe, must be as direct and clear as the situation will permit, and care should be taken to prevent any fire starting through the leakage of transformer oil in case of a burnout. The traveling-crane arrangements should enable any piece of apparatus to be quickly removed to a safe place in case it becomes short-circuited or otherwise damaged. Plenty of clear space around and above all the machinery is a good plan to work toward, as far as the cost of real estate and building construction will allow.

In telephone exchanges considerable danger exists from fire caused by overheated switchboard cord circuits, or the careless use of torches around the lower part of the switchboard. It is highly advisable to install fire-proof barriers between the cord shelf and the multiple jacks, forming a continuous horizontal separation throughout the switchboard between the cabling and the cord shelf, thus protecting the cables from any fire originating below the partition. These bulkheads, as manufactured by the Bell interests, are made to be readily removable in case it is necessary to work about the switchboard.

In localities where ice is likely to be formed if water alone is used in fire pails, freezing may be prevented by the mixture of either common salt or calcium chloride with the water. The American Telephone and Telegraph Company recommends the following specific gravities:

CALCIUM CHLORIDE.		SODIUM CHLORIDE.	
Sp. Gr. 60° F.	Freezing Point.	Sp. Gr. 60° F.	Freezing Point.
1090	20° F.	1065	20° F.
1140	10°	1125	10°
1175	0°	1190	0°
1205	—10°		
1225	—20°		

These solutions are corrosive, and should never be used about switchboards or other electrical apparatus except in extreme emergencies. Fire pails for this use should be galvanized or else painted with asphaltum or tar.

The cost of properly protecting an electric plant from fire will naturally vary widely. Hydraulic plants for long-distance power transmission seldom require the attention in this line which steam plants demand. A few hundred dollars go a long way toward completely protecting all but the largest plants from all fires except those which, humanly speaking, are unpreventable. Safety to life is principally a matter of exits and escapes. The majority of electric-power plants are buildings of one or two stories only, and seldom need extensive external fire escapes. Probably the telephone exchange has the greatest risk to face. Two or three separate exits should always be at hand in these buildings. Every employee should know exactly the resources of his company in the line of fighting fires. Little excuse exists for refusal to spend the small amount of money necessary to secure the greatest safety available in the light of present knowledge.

METAMORPHOSIS OF WIRELESS-TELEGRAPH APPARATUS.

By A. Frederick Collins.

It has always been our assured belief that space telegraphy was destined to supplement, not supplant, the older methods. In this field of new and additional service, however, there has been ample room for growth, and for a development which has transformed almost every feature of the apparatus into something wholly different from that which was found in the first systems. It is the result of this epoch of change that Mr. Collins reviews in the following pages.—The Editors.

DURING the past seven years the means employed for the production, propagation, and reception of electric waves have undergone a change almost as complete as that indicated in the evolution of a caterpillar into a butterfly.

In order to observe the striking advances in the construction of wireless telegraph apparatus it is necessary only to refer to the earlier types of transmitting and receiving instruments, and to compare them with those of more recent origin; by this statement it is not intended to convey the impression that the latest productions are embodied in a specific apparatus, but rather in a theoretic combination representing synthethically the final products of the brains of many workers in space telegraphy.

Again, it must not be inferred that the fundamental principles underlying the art in 1896 have been superseded by other and newer ones; for, on the contrary, the same inherent laws that prevailed then govern the ultimate actions of the electric wave transmission to-day. Hence the necessity for briefly reviewing the original appliances, first for transforming the kinetic energy of electricity into high-potential energy, then converting the static charges into high-frequency, high-voltage currents, the inherent nature of which causes their energy to be damped out, giving rise instead to ether waves in space; and second, the reactionary processes wherein the received wave impulses are by their own imminent quality converted into electric oscillations when, by suitable translating devices, their differentiation is manifested as decipherable signals.

Type of 1896 Transmitter.—The transmitter devised and used by Marconi in his earliest experiments is shown in Figure 1; it comprises a battery, 1, in series with a modified telegraph key, 2, a mechanical vibrating spring interrupter, 3, and the primary winding, 4, of a Ruhmkorff induction coil; in shunt with the interrupter 3 when it is making contact, and in series with the primary circuit when the interrupter breaks contact, is a condenser, 5; the terminals of the secondary winding, 6, of the induction coil leads to both sides of the oscillator, 7 7′, and from the opposite arms of the latter an aerial wire 8 and a grounded terminal 9 are attached.

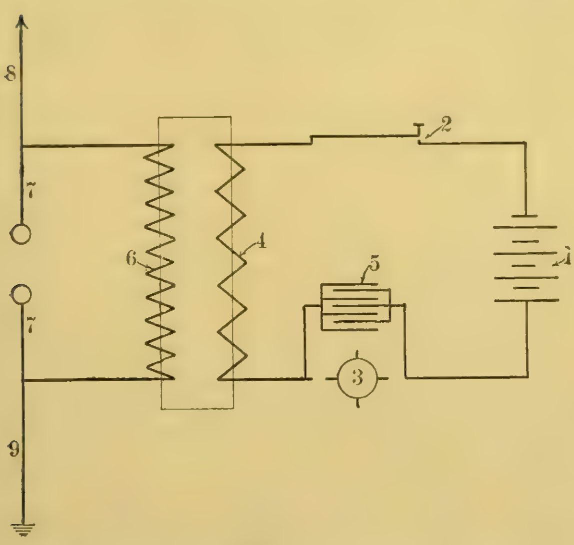
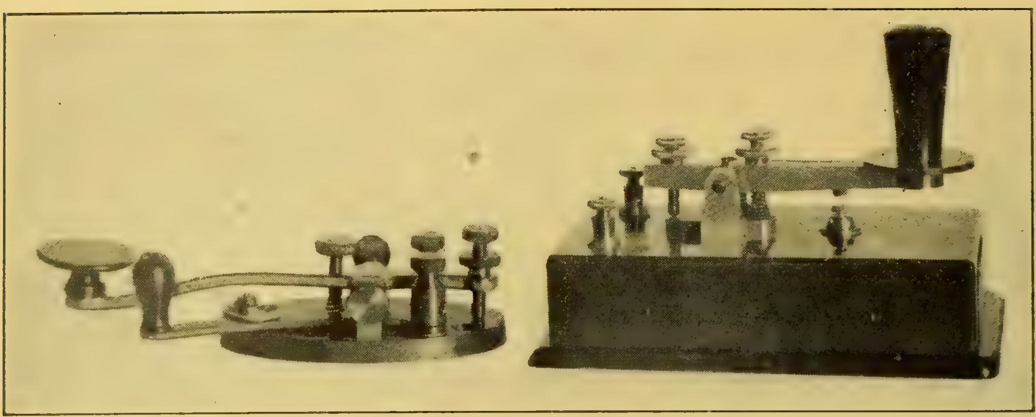


FIG. I. MARCONI TRANSMITTER, TYPE OF 1896.

The function of the different parts of the transmitter in the successive translations of the current when the circuit is closed through the key 2 and the interrupter 4 is as follows:—the current from the battery energizes the primary coil and a magnetic flux is produced, the curved lines of force flowing through the soft-iron core represented by the dotted lines, and these spread out in semi-circles surrounding the coil longitudinally and intersect each convolution; by the well-known laws of induction this induces in one direction a current of high voltage in the secondary coil.

This current gives rise to a static change in the arms of the oscillator, 7 7′, until the potential energy reaches a point at which it will disrupt the air-gap 10, when it is converted into a high-frequency current in the oscillator system. When the primary circuit is broken by the interrupter, a momentary current is induced in the secondary coil in a direction opposite to that of the first induced current, and the inducing primary current flows into the condenser 5; this "make and break" process is repeated automatically until the key 2 is opened, when all operations cease.

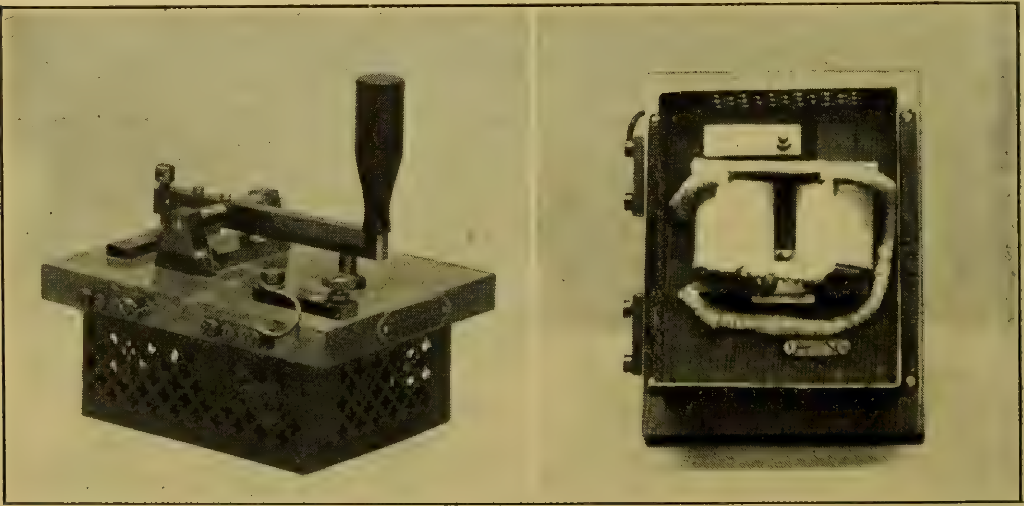
The condenser is shunted around the interrupter, to decrease the sparking of its contacts due to the inductance of the primary current. The capacity of a condenser should have as small a value as will give the maximum length of spark between the terminals of the secondary. This is termed by Johnson its *optimum capacity* and Dr. Ives has proposed a formula for it; it has also been shown by Lord



FIGS. 2 AND 3. ORDINARY TELEGRAPH KEY, AND MARCONI KEY WITH LARGE CONTACTS.

Rayleigh and others that the smaller the time with which the break was made, the smaller the optimum capacity became, so that if an instantaneous break were possible there would be no time for the inductance to rise and the artificial capacity could be eliminated. These and other problems afforded ample opportunity for improvement and this took place along the following lines.

Telegraph Keys.—The making and breaking of the primary current into the alphabetic code of dots and dashes for wireless telegraphy is a matter of importance, and the necessity for modifying and adapting the regular Morse key to this purpose was found desirable very early in wireless-telegraph practice. An ordinary telegraphic key, shown in Figure 2, is of course the most convenient device for manually breaking up the current; but since its carrying capacity is exceedingly limited it is suited only to the working of small coils. Another undesirable feature of this type of key is the constant danger of shock from the high-voltage currents of the secondary due to leakage.



FIGS. 4 AND 5. BRAUN KEY, TOP AND BOTTOM VIEWS.

Marconi designed a simple lever key of large dimensions, amply protected by ebonite insulation and having large brass contacts; the arrangement is illustrated in Figure 3. To cut down the abnormal sparking, condensers have been shunted around the break of the key. In the Slaby-Arco and Braun systems the contacts of the key are provided with electromagnets for blowing out the spark formed on breaking the primary circuit, this arrangement being based on Davy's discovery of the action of a magnetic field upon a voltaic arc, which has in recent years been the subject of much litigation in the United States in the Thompson magnetic blow-out suits. By referring to the photographs Figs. 4 and 5 it will be observed that the magnet is placed in the base of the key where it will not interfere in the manipulation of the lever.

All the above types have a high time constant, owing to their large dimensions, and to overcome this objection both Fessenden and De Forest have chosen a regular Morse key and equipped it with such additional appliances as to meet the requirements of heavy current service and rapid signalling. In the De Forest key, Figure 6, the circuit is broken under oil, and this permits not only of rapid manipulation but also of breaking heavy currents without danger to the apparatus or the operator.

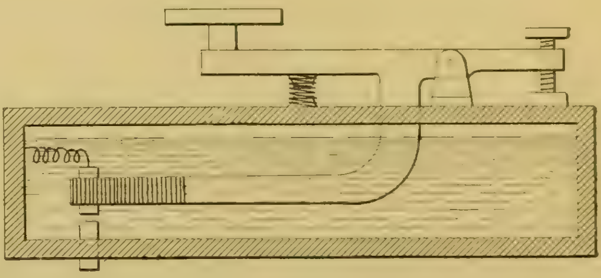


FIG. 6. DE FOREST KEY.

In the Fessenden key a regular Morse key is provided with a vertical rod attached to the end of the lever; to the rod, fingers are fastened so that when the key is depressed these come in contact with wires of a tuning grid and a shunt circuit is formed; by this arrangement the induction coil may be operated continuously and the sending circuit may be thrown in and out of tune in consequence and waves emitted accordingly.

Induction Coils.—Theoretically considered, the induction coil has been carefully and consistently studied since the advent of the wireless telegraph, by such authorities as Lord Rayleigh, Klinglefuss, Walter, Overbeck, Cooley, Jamison, Jaumann, Johnson, and Ives, and many valuable suggestions have been offered for its improvement; but the mechanical construction of the coil has been advanced chiefly on empirical knowledge and the improvements consist in providing better insulation, extending the length of the soft-iron core, and decreasing the length and increasing the radius of the wire with which the secondary is wound.

In Figure 7 an ordinary induction coil with vibrating interrupter, typical of the pre-wireless-telegraph period, is shown; whilst Figure 8 is a form designed by Fessenden and Figure 9 is the style employed in the Braun-Siemens & Halske transmitter. The two latter induction coils are constructed especially to fulfil the severe requirements demanded by actual service in wireless-telegraph practice.

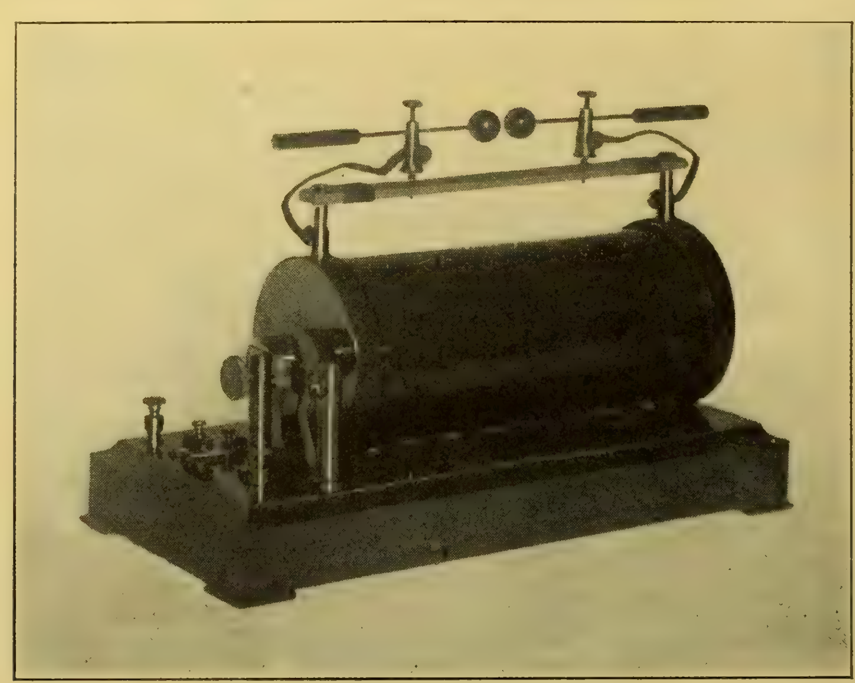


FIG. 7. ORDINARY INDUCTION COIL.

In the Braun-Siemens & Halske coil the diameter of the soft-iron core is large compared with its length, and in the Fessenden coil the core is long compared with the length of the secondary. The best results are obtained when the coil projects about one-fifth of its length beyond the secondary at each end. With a coil of the above dimensions the length of the secondary wire may be minimized, since a greater number of lines of magnetic force will interest each convolution of wire in the secondary at the middle of the primary than at its ends. Then by winding the secondary with wire of comparatively large diameter, increasing its insulation, and carefully treating it to exclude air and moisture, a coil is obtained which possesses remarkable efficiency, eliminates the possibility of electrostatic bombardment which often causes disruption, and minimizes the amount of wire required.

Interrupters.—A simple mechanical vibrating-spring interrupter is shown in Figure 10 and was invented by Wagner and Neff over

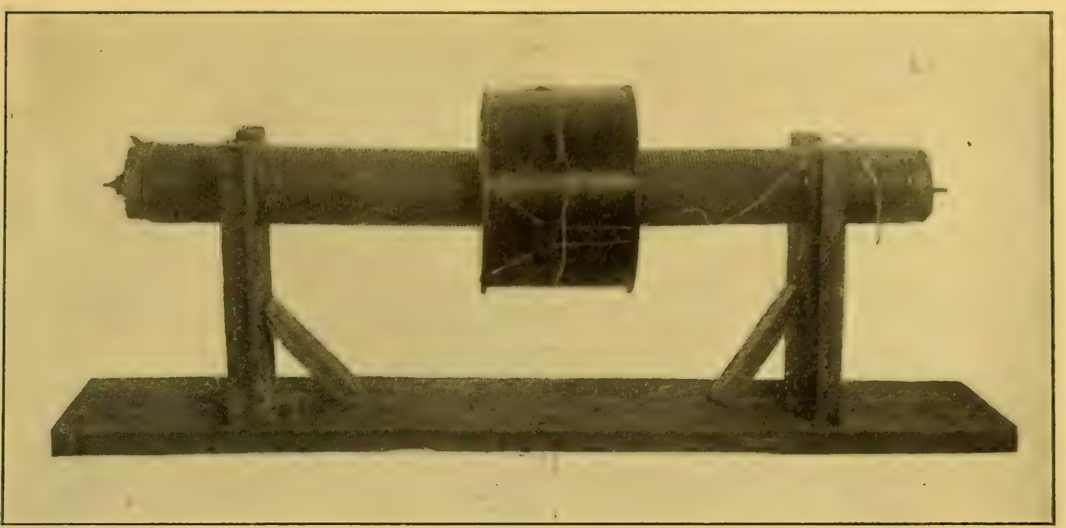


FIG. 8. FESSENDEN INDUCTION COIL WITH LONG INNER COIL.

fifty years ago. This device gives approximately 100 breaks per second. It was the earliest type of interrupter used in connection with an induction coil for wireless telegraphy, and is the simplest and easiest managed type of automatic interrupter made; but its low speed renders it very inefficient, since the radiation of electric waves is proportional to the energy output per unit of time.

To increase the effective radiation the mercury-jet interrupter has been found to give very satisfactory results, and is specified in sev-

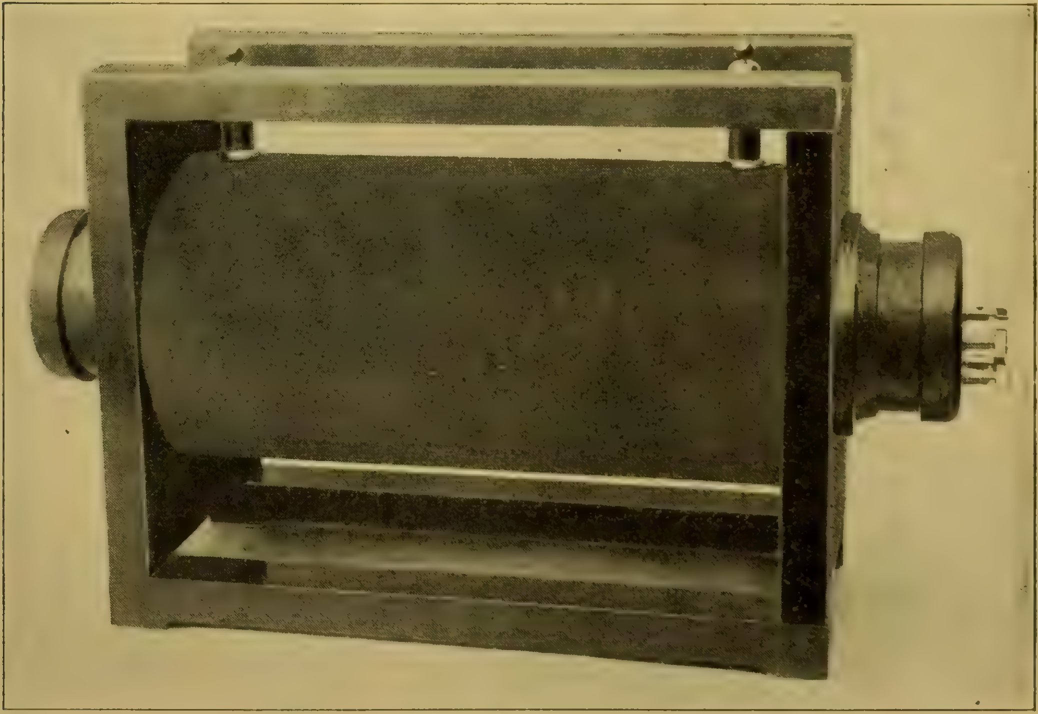


FIG. 9. BRAUN-SIEMENS & HALSKE INDUCTION COIL.

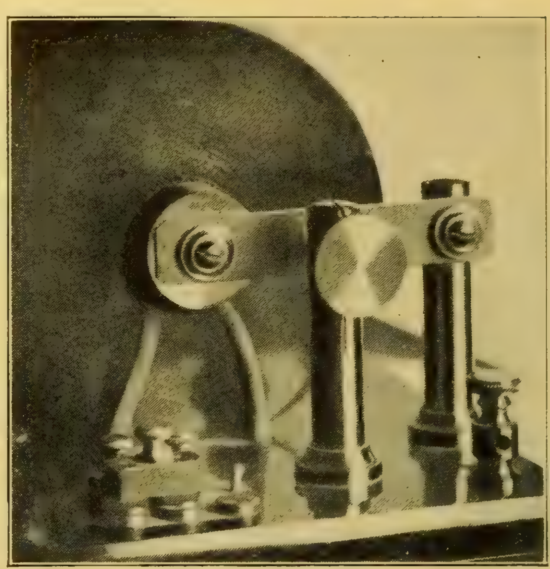


FIG. 10. SIMPLE VIBRATING INTERRUPTER.

eral of the systems notably the Slaby-Arco. In its usual form, it comprises an enclosed case, having a hollow vertical spindle fitted with an interior screw which when revolved drives the mercury contained at the bottom of the vessel up and out of two oppositely disposed lava-tipped tubes, the centrifugal action projecting the mercury in a steam against two or more sheet-iron sectors; these are connected to the terminals of the induction coil, the circuit being formed through one sector, in at one jet, out of the other jet, and through the second sector.

After impinging on the sectors the mercury falls back into the vessel to be used over and over again. The break, owing to the great centrifugal velocity of the mercury jet leaving the edge of the sector, is exceedingly sudden. The frequency of the interruptions is variable, and may be 10 or 10,000 per minute, and currents of 25 amperes may be safely carried. While the break is nearly instantaneous it is not ideally so, and therefore a small compensating capacity is required in shunt with it.

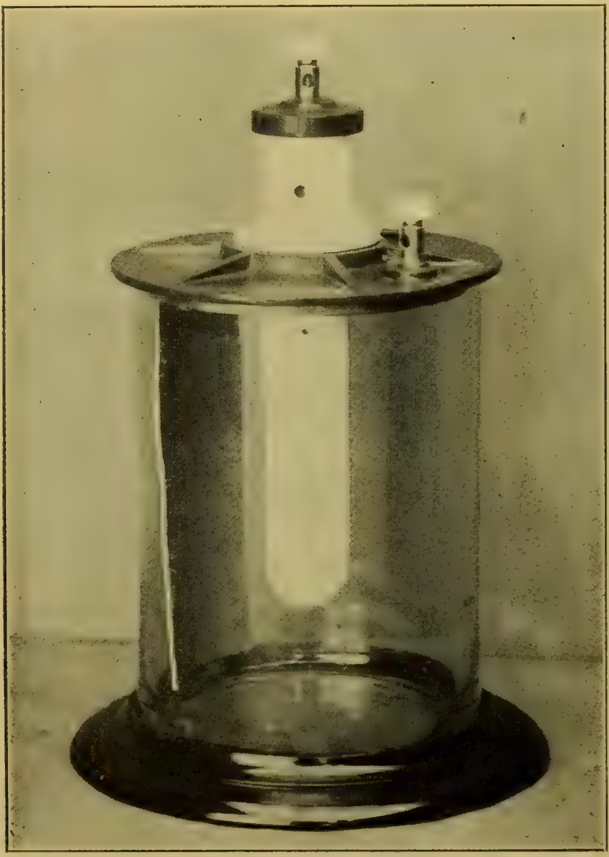


FIG. 11. ELECTROLYTIC INTERRUPTER.

To eliminate the condenser as a factor in making and breaking the circuits, the electrolytic interrupter has found considerable favor and is included in some of the systems, among them the Braun-Siemens & Halske. The frequency of the breaks ranges from 1,000 to 10,000 per minute. An electrolytic interrupter, Figure 11, consists of a platinum anode having a surface of a few square millimeters, and a lead cathode having a surface of a few hundred square centimeters. Exceedingly sharp breaks take place at the platinum terminal, since minute bubbles of non-conducting gas are instantly and constantly formed, the frequency of which varies directly as the electro-motive force employed and inversely as the area of the platinum exposed. The break is not sharper than in the mercury turbine interrupter, but it possesses an inherent electrolytic capacity sufficient to counteract the inductance of the circuit. The objectionable feature of the mercury interrupter is that deposits occur requiring the frequent cleansing of the apparatus, while in electrolytic interrupters there is always the liability of an explosion due to the electrical ignition of gases formed in the process of electrolysis.

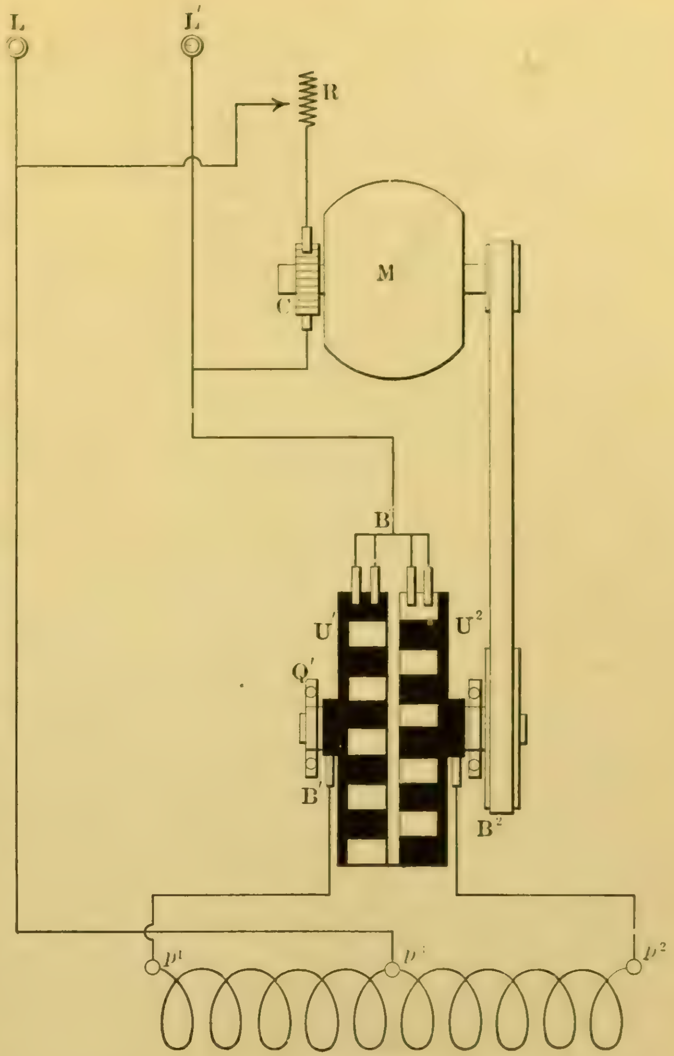


FIG. 12. GRISSON ROTARY INTERRUPTER.

The Grisson continuous alternating-current converter was designed for the transformation of heavy currents mechanically. The device, as its name implies, converts a direct current in the primary coil into an alternating current in the secondary coil. The frequency of alternation ranges from 1,000 to 6,000 per minute and currents of any amperage may be safely used. In the diagram, Figure 12, the scheme will at once be apparent; p^1 p^2 p^3 represent the primary winding of an induction coil; one of the leading-in wires, L, is connected direct to the middle convolution, p^3; the opposite wire, L^1, leads to a pair of brushes, B^3, where the current is divided on the segmental discs U^1 U^2, which are both fastened on a common shaft but insulated from each other.

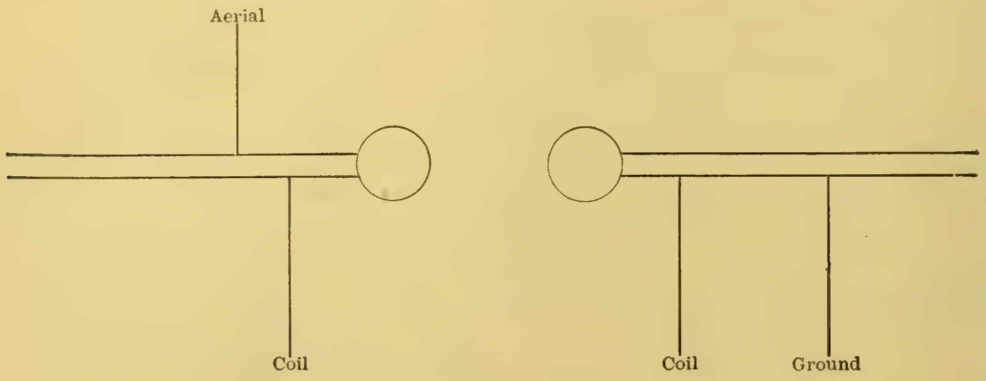


FIG. 13. HERTZ AIR SPARK GAP.

When in operation, continuous currents flow from the wires B^1 B^2 connected to the terminals of the inductor p^1 p^2; this flow continues for the period the brushes B^3 remain in the position shown, when the circuit through the inductor is closed and the maximum value of the current in one direction becomes effectual. As the discs revolve so that the brushes B^3 rest on segments of the commutator, the value of the current will have reached ° and the opposite half of the inductor will be energized and a current in the reverse direction will take place in the secondary winding of the coil. The most objectionable feature found in this converter is the excessive sparking unless the brushes on the segmental disc are adjusted with extreme accuracy.

Spark Gaps.—In Hertz's paper relating to his experiments in electric-wave phenomena, he states that he used an ordinary air spark gap as in Figure 13 for setting up the oscillatory currents, the disruptive discharge taking place between metal spheres connected with the terminals of the secondary coil; and this simple method is largely employed at the present time. The spark gap has however passed through a number of transitions looking toward the fulfilment of more nearly ideal conditions.

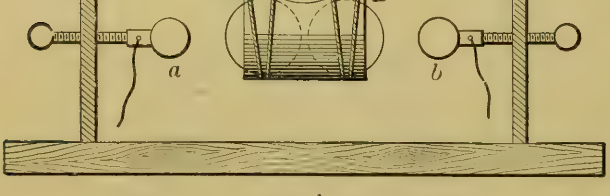


FIG. 14. RIGHI'S OSCILLATOR.

Righi, the preceptor of

Marconi, sought to obtain a more uniform discharge by providing the spark gap with two large brass spheres A B, Figure 14, separated a distance of a millimeter and having their opposing surfaces arranged in a fluid-tight compartment of hard-rubber containing oil; the outside of each sphere was exposed and receives its charge from the small brass spheres *a b* connected to the secondary of the coils. In Marconi's early apparatus the terminals of A and B were connected to the aerial and earth wires respectively. It was assumed that the inside hemispheres forming the spark gap were kept bright by the oil and that regular and uniform oscillations resulted in consequence. Later these advantages were disclaimed by Marconi, who returned to the simple spark gap of Hertz.

The properties of the disruptive discharge in air under different pressures have been carefully investigated by Fessenden. In his experiments he found that by increasing the pressure of the air its dielectric strength is also increased, and the potential of the oscillator can be enormously increased without decreasing to any appreciable extent the potential of the oscillatory discharge; in this respect it is decidedly more efficient than air under atmospheric pressure, since in the latter case no matter how high the potential is raised no increase in efficiency is obtained after the first inch of spark length is reached. The apparatus for producing the disruptive discharge in compressed air is shown in Figure 15; it consists essentially of an air compressor, 1, and an air chamber, 2; the spark gap is formed between the insulated terminal 3 and the base of the chamber 4; these are attached to the terminals of the secondary and the aerial and earthed wires. By means of this arrangement it is claimed that it

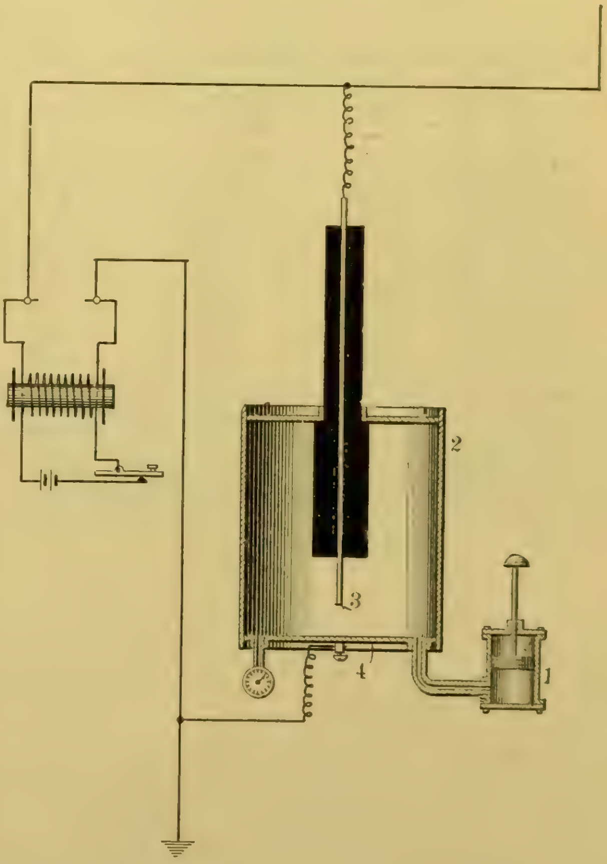


FIG. 15. FESSENDEN'S COMPRESSED AIR SPARK GAP.

is possible to maintain a certain definite relation between the co-efficients of the circuit without regard to the potential employed.

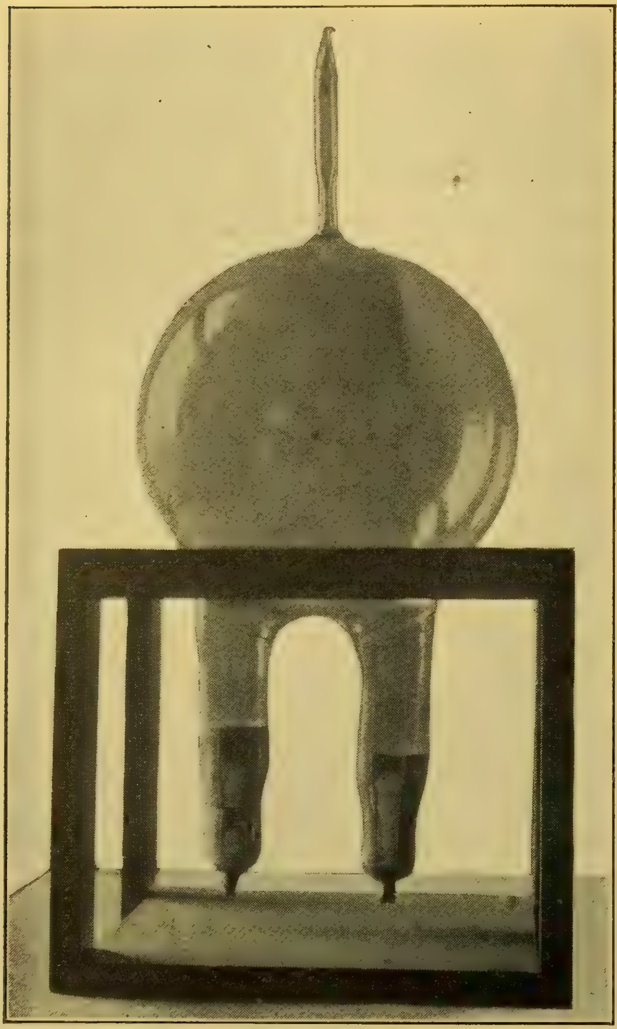


FIG. 16. COOPER HEWITT INTERRUPTER.

A recent device for regulating the frequency of the spark discharge and converting all the energy into effective radiation is shown in the photograph Figure 16; it is the invention of Cooper Hewitt, and is termed by him an interrupter; but in this case it is interposed between the terminals of the secondary coil instead of the ordinary spark gap. It consists of a modified mercury-vapor lamp in the form of a glass bulb, 8 to 10 inches in diameter and having two sealed tubes in the lower portion containing mercury; leading-in wires form connections with the mercury, and the bulb is then exhausted and hermetically sealed.

The interrupter is connected to the terminals of an induction coil or to condensers in circuit with a secondary of a tranformer operated by an alternating current. When in action the negative electrode offers a resistance to the flow of the current and a potential difference is thus established between the two electrodes until a certain high critical value is reached, when the resistance is broken down; the current then passes without opposition until the difference of potential is nearly equalized, when the initially high resistance again manifests itself instantaneously.

The frequency with which the discharge takes place depends on the inductance and capacity of the circuit and the electromotive force impressed upon it. 2,000 volts will produce an automatically interrupted discharge, while any higher pressure up to 100,000 volts may be employed if desired. As in an ordinary spark gap, the currents set up are oscillatory and the frequency with which the discharges may be effected is limited only by the time required for the charging and discharging of the condensers. By actual tests it has been shown that there is a much greater economy in radiation by means of the mercury interrupter than in ordinary air spark-gaps, since nearly all of the potential energy is converted into kinetic energy in the former.

The last great advance in transforming low-voltage currents into high-voltage alternating currents was made by Fleming, who proposed a method by which the interrupter was entirely eliminated; to effect this, the interruped primary direct current was substituted by a low-voltage alternating current and this was converted into a high-voltage current by means of a commercial alternating-current transformer.

The schematic arrangement is shown in Figure 17. An alternating current generator, 1, is connected with the inductor, 2, of a transformer; the terminals of the secondary winding, 3, are connected in series with a suitable capacity, 4, such as a number of Leyden jars; shunted across this circuit is a spark gap, 5. The operation of this transmitter is exceedingly simple. When alternating currents of low frequency and voltage surge through the primary circuit, which includes the inductor, they induce currents of similar frequency but high voltage in the secondary winding.

Thus a current of 25,000 to 50,000 volts may be had at the terminals of the secondary by utilizing a 500-volt alternating current in the primary. The high-voltage current charges a battery of Leyden jars until the high-potential energy thus stored up finally breaks down the air gap and a disruptive discharge results, converting the static charge into kinetic energy in the form of high-frequency oscillations.

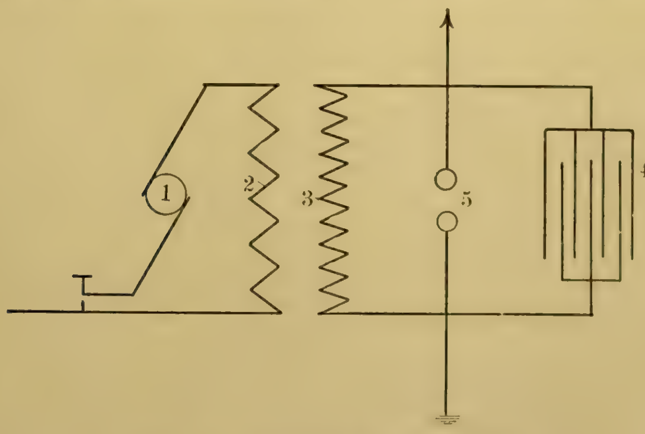


FIG. 17. FLEMING TRANSMITTER.

This is at once the simplest and most efficient transforming apparatus for wireless-telegraph transmitters, and has the advantage over the induction coil in charging both arms of the oscillator system with equal energy at every reversal, and a current of any amperage may be utilized.

1896 Type of Receiver.—The earliest type of apparatus devised for receiving electric waves and for indicating their presence is illustrated in Figure 18. It consisted of a wave detector in the form of a coherer interposed between the aerial wire and the grounded conductor which formed a resonator system. Since the action of the impressed oscillations on the filings of a coherer is imperceptible to the unaided eye, but is very pronounced in its effect on an electric current, a local circuit is formed which comprises the coherer, *j*, a single dry cell, *g*, and the magnets of a sensitive polarized relay, *n*; a second local circuit includes the contact points of the relay, a battery, *t*, for energizing the tapper magnet, *p*, and for actuating the Morse printing register, *h*. The performance of the various appliances from the action of the electric oscillations on the coherer to the printing of the code on the tape requires some explanation.

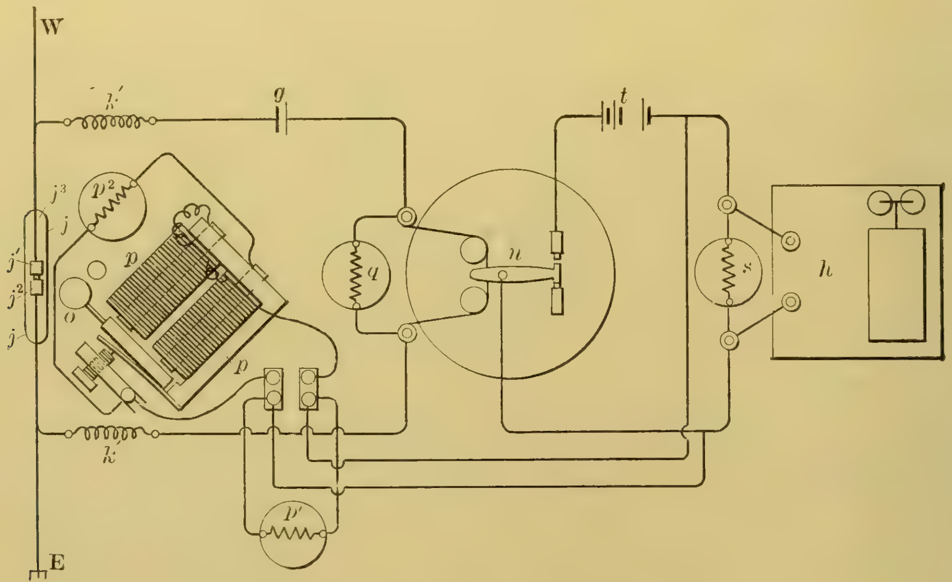
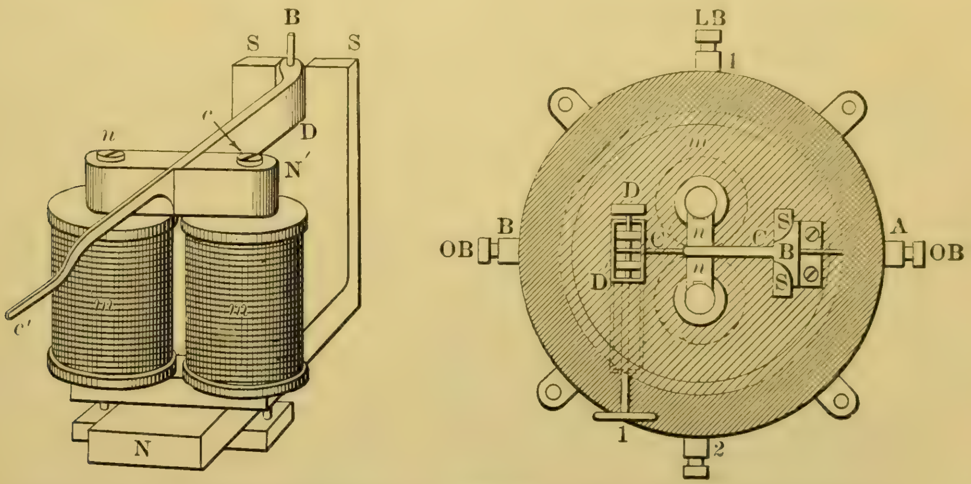


FIG. 18. THE MARCONI RECEIVER OF 1896.

When the oscillatory currents set up by the incoming electric waves meet with the resistance offered by the metal filings of the coherer, the metallic particles are electrically charged to opposite signs, just as are the spheres forming the spark gap of the radiator; but the former being exceedingly small, the air films separating them are correspondingly minute, and when the charges reach a certain maximum critical value the films of air are disrupted and the filings cohere, not merely by mutual attraction (although this is what probably first occurs) but in the last degree they are actually welded together so that where the normal resistance may have measured thousands of ohms it is lowered to as many tens. Hence, where the current of a local cell could not appreciably manifest itself through the local circuit before the action of the oscillatory current, it now flows feebly through it and energizes the magnet of the relay.

By this action the armature of the relay is attracted and brings into contact a stationary and movable platinum point which closes a second local circuit; this accomplished, a local battery renders the de-coherer operative and causes its tapper to strike the tube and break the filings apart, thereby restoring the coherer to its normally high resistance. Simultaneous with the foregoing the same current actuates the magnets of the register, starting the spring motor and imprinting on a moving tape a dot or a dash.



FIGS. 19, 20. POLARIZED RELAY; GENERAL VIEW AND TOP ELEVATION.

The capricious action of the coherer, together with the element of time required for the consummation of the preceding processes and the necessity for constant adjustment of the instruments, indicated plainly that improvements were in order.

Relays.—The ordinary line relay was used in the earliest experimental receptors. In its usual form, as is well known, an electromagnet is secured to a frame in a horizontal position; its armature is delicately pivoted and is provided with contact points, and the movements of the former open and close the local circuit containing the tapper and register. This type of relay is usually wound to 150 ohms and does not possess nearly the sensitivity demanded in the practice of wireless telegraphy.

Recourse was had to the polarized relay, an instrument of extreme sensitiveness considering the mass of metal it controls; the ordinary type consists of an electromagnet *m m* Figure 19, with soft-iron cores resting on the positive pole of a permanent magnet; when no current is flowing through the coils of the magnet both polar projections *n n* are positively magnetized, but when a current, however feeble, flows through the coils, one of the poles of the electromagnet becomes more strongly positive, while the opposite changes its polarity to negative.

This causes the armature lever to be attracted and repelled without the aid of a retractile spring. This lever c c^1 is of soft iron and is pivoted at B on the negative pole s s of the permanent magnet; it is constructed so that it will just clear the polar projections *n n;* the end of the lever *c* when no current is flowing rests against an insulated stationary contact, D, Figure 20; but when the current passes the lever is drawn into contact with D^1, closing the second local circuit in which the decoherer and register is placed. Figure 21 is a photograph of the polarized relay used in the Marconi system. Since it is balanced by magnetic action and its coils are often wound to a resistance of 10,000 ohms, a very feeble current may be utilized for throwing into circuit heavy currents. The polarized relay is employed as an intermediate appliance between voltage-operated wave detectors and the indicating

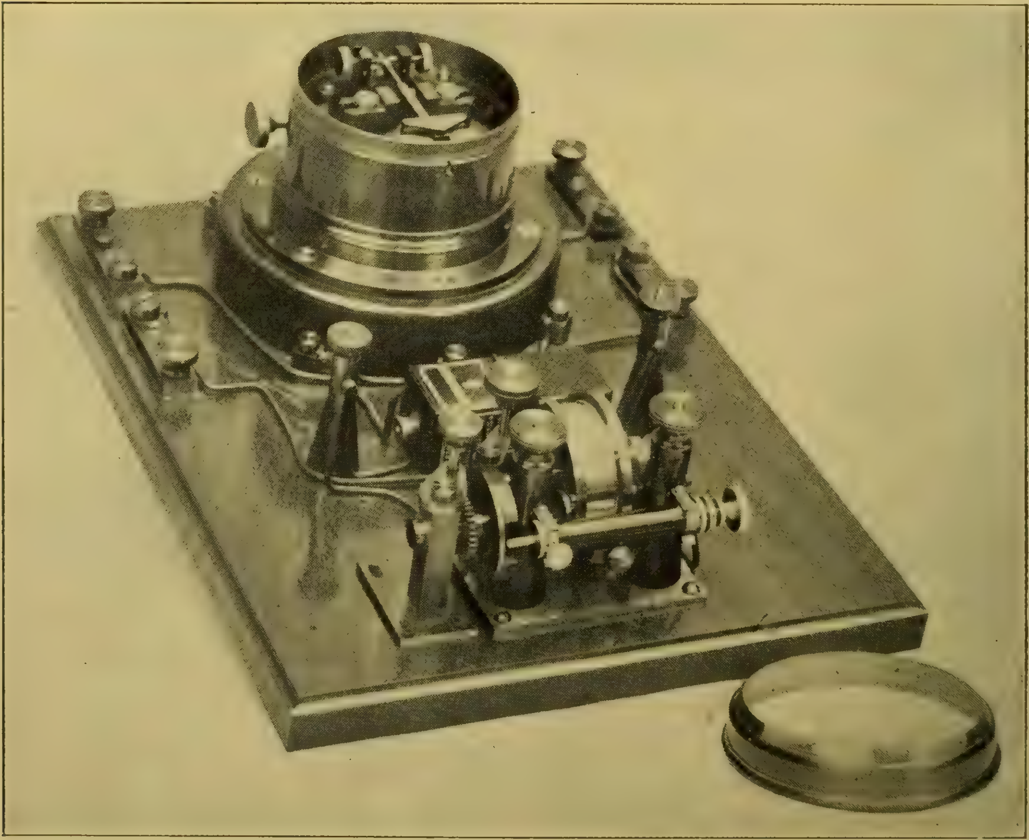


FIG. 21. POLARIZED RELAY (IN THE BACKGROUND), AND FIG. 23. BRAUN-SIEMENS & HALSKE TAPPER.

mechanism except in the Lodge-Muirhead system, wherein a coherer and a siphon recorder are direct-connected.

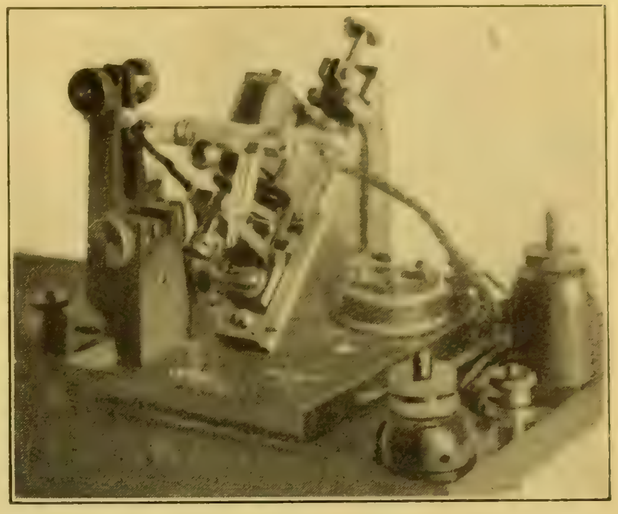


FIG. 22. THE MARCONI TAPPER.

Decoherers.—In the matter of decoherers there has been little need for improvement, the earliest contrivances serving fairly well the purpose for which they were constructed. In Figure 22 a Marconi tapper is shown. It consists essentially of an electromagnet having an automatic contact breaker similar to an electric bell. The armature lever is permanently attached to the frame by means of a straight, stiff, steel spring, the elasticity of which draws the armature away from the poles of the magnet and into contact with a platinum point connected in series with the magnet armature and source of current.

The striking hammer is placed very close to the armature so that its period of vibration may be quickened, for its time constant when compared with the movement of the printing lever of the register must be low; the ratio should be as five is to one—so that the former should vibrate at least five times to every stroke of the lever of the register; it is this ratio of adjustment that permits a series of wave impulses to be registered in a continuous line representing a dash. Screws for moving the magnets and for obtaining the proper relation between the coherer and magnets are provided.

By referring to Figure 24 representing Guarini's decoherer the arrangement will be more clearly depicted. The spiral spring and screw gives a micrometer adjustment permitting strokes of any degree of delicacy to impinge upon the coherer. In the Braun-Siemens & Halske receptor an electromechanical decoherer is employed in contradistinction to those described which are purely electrical in operation. In this device the lever of the tapper is operated mechanically by a spring motor, the latter being actuated by a local current. It is evident that in electrically operated tappers the strength of the strokes varies proportionally to the strength of the current. In mechanically operated decoherers the blows are delivered with exactly the same force regardless of the current. The arrangement is illustrated in Figure 23.

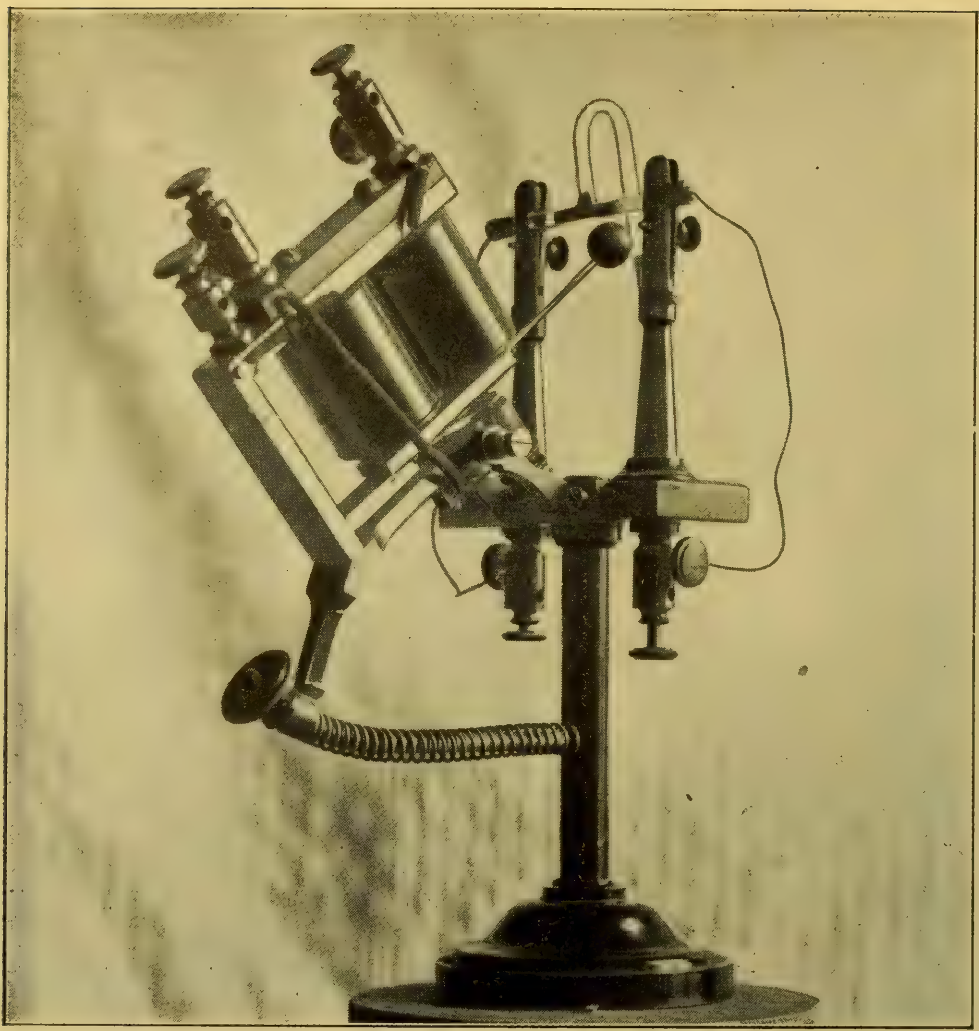


FIG. 24. GUARINI TAPPER AND BLONDEL'S REGENERABLE COHERER.

Electric-Wave Detectors.—There has been more time and energy expended by inventors in the improvement of electric-wave detectors than in any other one part of the receiving apparatus. Branly's discovery of the action of electric waves on metal filings belonged to the pre-wireless period; his radio-conductor, diagrammatically represented in Figure 25 was however the prototype of the modern coherer. It will be observed that A B and C D are conductor plugs, the cavity of the ebonite cup containing the metal filings; when sparks passed between the knobs of a frictional machine, though the detector was 10 meters distant, the resistance of the filings was decreased by hundreds of ohms.

Lodge modified this detector and gave it the name of coherer. With it he experimentally showed the possibility of using a Hertz transmitter for sending messages wirelessly. His coherer, Figure 26, consisted of a glass tube having a bore of 1 centimeter and a length of 18 centimeters; the ends were provided with conductor plugs so that the pressure upon the filings could be adjusted by means of a screw. The resistance of the filings was enormous in virtue of the great cross section and length of the tube.

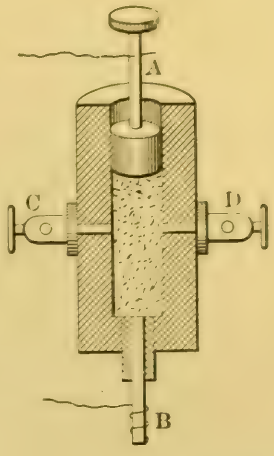


FIG. 25. BRANLEY'S RADIO-COHERER.

The coherer designed by Marconi for his early experiments was a gigantic stride toward the goal of commercial wireless telegraphy. His coherer is shown full size in Figure 27, and the metamorphosis of the Lodge coherer into the one under consideration was the result of three improvements, namely:—decreasing the size of the tube and the amount of the filings, substituting nickel and silver filings for brass or aluminum, and exhausting the tube of its air. In these details, together with extreme care taken in the construction of the tubes, lies the chief secret of Marconi's success.

The conductor plugs are of silver and are made to conform to the inside diameter of the tube; in the pocket thus formed a mixture of 90 per cent. of silver and 10 per cent. of nickel is placed, and the tube tested for sensitiveness, after which the wire terminals leading from the conductor plugs are sealed in, and finally the tube is exhausted by means of a mercury air pump and the nipple sealed off when the coherer is ready for use.

Very early in the history of wireless telegraphy it was pointed out that carbon and some other substances were self-restoring—that is, the effect of the oscillations in lowering the resistance offered by them was momentary and the instant the oscillations ceased the granules by an inherent property instantly decohered. While carbon does not require a tapper to restore it to its normal resistivity, the range of variability between maximum conductivity and maximum resistivity is so exceedingly small that the most sensitive relay is not affected by it. Therefore a telephone receiver is used in connection with it.

The speed with which auto-coherers operate was an advantage of

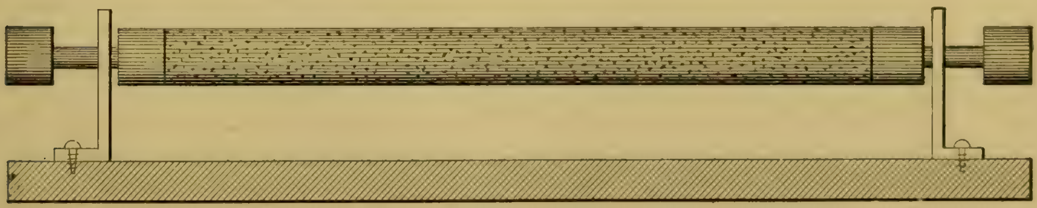


FIG. 26. LODGE'S FIRST COHERER. ABOUT ½ SIZE.

great importance and their characteristic principles have been utilized in different systems.

One of the most sensitive detectors of electric waves is due to Dr. Lee de Forest, who made exhaustive tests with self-restoring devices and finally discovered that a mixture of oxide of lead and glycerine would respond to the feeblest oscillations. Its action is due to electrolysis and the diagram A Figure 28 gives a graphic representation of how metallic threads are built up through the mixture by the local direct current between the conducting plugs forming the anode and cathode, while B indicates how these threads are disrupted by the oscillations. Hence the responder is an anti-coherer, *i. e.,* its normal resistance is low but is greatly increased when the oscillations effect disruption.

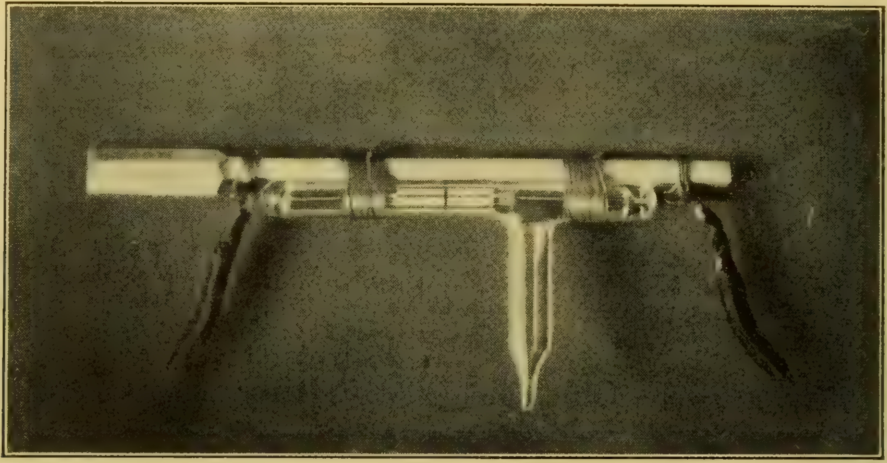


FIG. 27. MARCONI COHERER.

It will be remembered that the press a year ago gave a great deal of space to the Solari coherer, which device, it was alleged, Marconi had appropriated for his own use in his Transatlantic tests. Lieut. Solari was the first to point out the exceeding sensitiveness of a globule of mercury when interposed between two iron conductor plugs as indicated in the diagram Figure 29; like the auto-coherers previously described its use is limited to a telephone receiver.

Lodge has devised a new and ingenious coherer which may not properly be termed self-restoring, yet its restorative properties are at every instant present. It comprises a small steel disk revolved by a spring motor and having its peripheral edge in constant contact with a column of mercury. In the diagram, Figure 30, *a* is the steel disc, *b* the mercury, *c* a platinum spiral making contact with the mercury, and *d* a containing vessel. It is also photographically depicted in Figure 31.

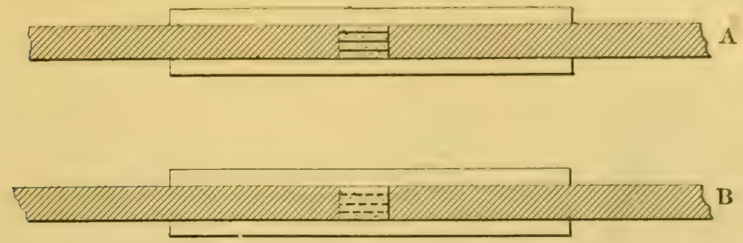


FIG. 28. DE FOREST ELECTROLYTIC RESPONDER.

It is obvious that the instant the oscillations cohere the particles of the mercury and steel the disc traverses a certain small arc of its revolution and the cohered molecules are broken asunder and a fresh surface is again exposed. It is a coherer of great sensitiveness and has a range of resistance variability wide enough to permit a siphon recorder to be actuated directly by it without the intervention of a relay.

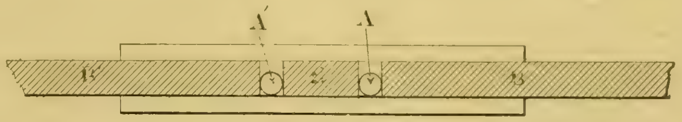


FIG. 29. SOLARI COHERER.
A, A′, globules of mercury; B, B′, iron plugs.

Marconi Magnetic Wave Detector.—The magnetic detector is based on the observations of Henry, Rutherford and others and involves the action of electric oscillations on magnetic bodies; the detector of Marconi combines with this phenomenon the principle of magnetic hysteresis. It comprises a glass tube of small diameter on which is wound a single layer of fine insulated wire, the terminals leading to aerial wire and earth respectively. A second coil of wire is slipped over the first coil and is connected in series with a telephone receiver; two grooved wheels are connected with a flexible band of iron wire and caused to traverse its course through the glass tube and small transformer by means of a spring motor.

Two steel horseshoe magnets are placed close to the coils; when oscillations are set up in the primary coil the magnetic intensity of the moving band of iron wire is changed and induced currents surge in the secondary coil and are indicated in the telephone receiver.

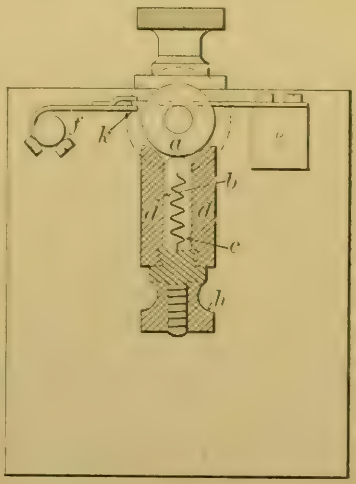


FIG. 30. LODGE COHERER.

The word *sensitiveness* as applied to the foregoing detectors is used in an arbitrary sense, but according to measurements made

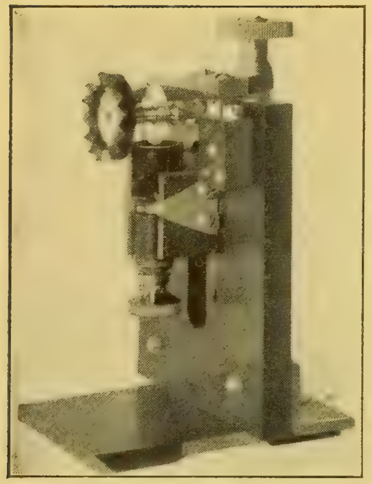


FIG. 31. LODGE ROTATING MERCURIAL COHERER.

by Fessenden it requires from one to four ergs to produce an indication with any of the above coherers, since they owe their changes in resistance to the *voltage* of the oscillations. Fessenden determined that a *current-operated* detector would offer advantages over those operated by voltage and based these deductions on his hot-wire barreter.* In his new liquid barreter, shown in the diagram, Figure 32, a small column of nitric acid with a minute platinum wire is used in place of the loop of fine wire formerly employed. Its principal advantage over voltage-operated coherers is its cumulative action, by means of which the entire energy received is utilized in producing indications.

By its use the sharpest tuning may be accomplished, and where coherers give resonant rises of less than 10 per cent. a barreter will give a resonant rise of at least 400 per cent. Once made it is always in adjustment; and again, it is not affected by atmospheric disturbances and it need not be enclosed in a grounded metallic box since a spark from an induction coil in the immediate vicinity of it will not affect it in the slightest degree. Last, but not least, its range of resistivity is sufficient to permit the use of a siphon recorder.

Indicators.—In the beginning of wireless telegraphy it was apparent that while the factor of time was practically negligible so far as the transmission of electric waves was concerned, yet this constant assumed a very high value in the actuation and operation of the apparatus. This is especially true of the receiver, as the various electro-mechanical apparatus require a specific time for the performance of their functions, limiting the number of words which may be successfully transmitted to twelve or fifteen per minute. It is difficult for an operator to read by sound the Morse characters where they are so slowly translated; again, atmospheric and other disturbance, produce "X's" or

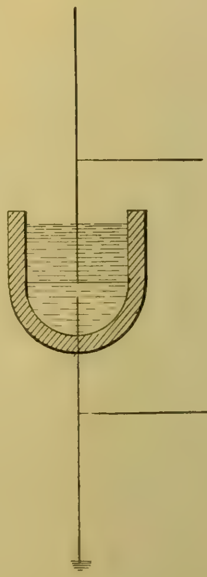


FIG. 32. FESSENDEN NEW BARRETER.

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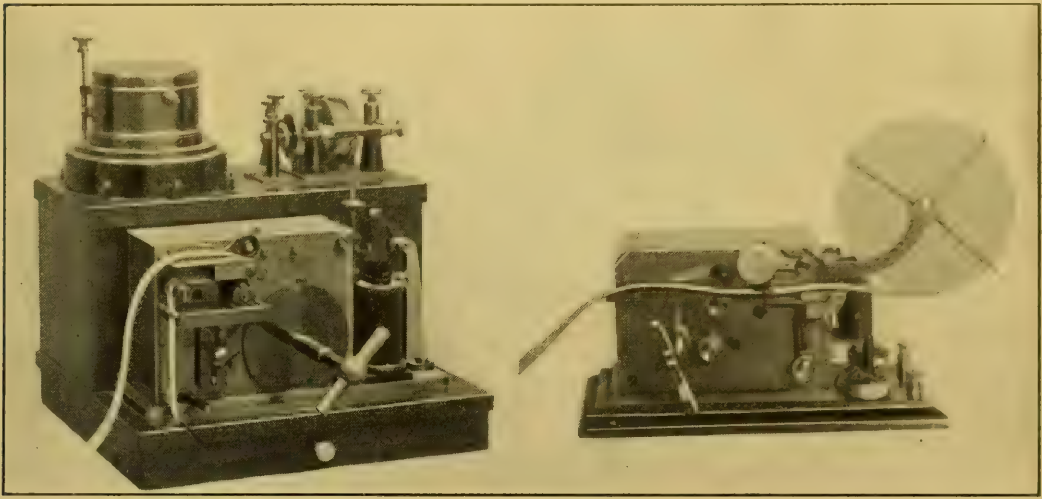
* Since the publication of my paper in THE ENGINEERING MAGAZINE, November, 1903, in which Fessenden's hot-wire barreter was described, he has invented the liquid barreter now described.

"strays," and these are confusing to the sense of hearing when recorded audibly; finally, it is often convenient to have a printed record.

These considerations lead to the adoption of the Morse printing register. The type used in wireless-telegraph receptors is in all respects similar to that employed in ordinary telegraphy, except that the armature lever to which the paper-guide is attached has a higher time constant. This permits successive dots, due to the breaking up of the local current by the action of the tapper on the coherer, to run together thus form the dashes of the code.



FIGS. 33 AND 33B. ON THE LEFT IS THE POLARIZED RELAY AND MORSE RECORDER OF THE BRAUN-SIEMENS & HALSKE RECEIVING SYSTEM. ON THE RIGHT IS A MORSE REGISTER OF THE AMERICAN TYPE.

The register consists essentially of a dust-proof brass case, with glass top, containing a spring motor and operating mechanism for drawing a paper tape at a pre-determined rate of speed under an inked printing disk revolving on a stationary pin. An electromagnet at the rear of the case is connected with the relay of the receptor and when energized by a local current, its armature is attracted, setting the motor mechanism into action and also causing the tape to be drawn into contact with the printing disc, thereby registering a dot or dash as the case may be. The usual form of register is shown in Figure 33. In the Slaby-Arco and Braun-Siemens & Halske receptors it is self-starting and self-stopping; in the Marconi apparatus it is started by hand.

The siphon recorder, Figure 34, is at present finding favor among wireless-telegraph engineers as a means of indicating messages, since by its use auto-wave-detectors, having a limited range of variability, may be employed without the intervention of a relay and at the same time a permanent record may be obtained.

In the siphon recorder a paper tape is set in motion as in the pre-

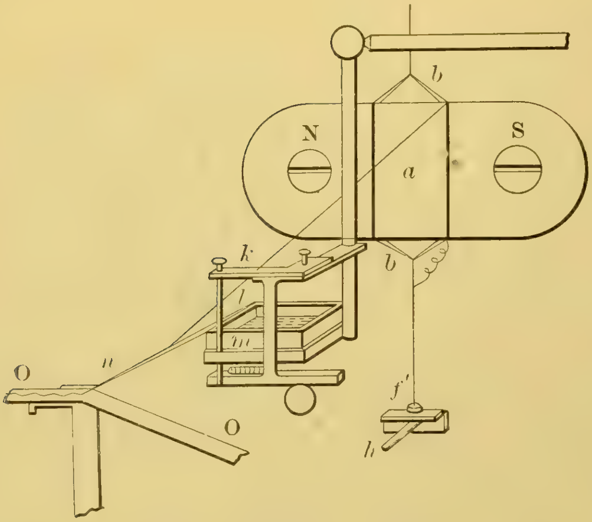


FIG. 34. SIPHON RECORDED.

viously described recorder. A fine glass siphon, receiving its supply of ink from a vessel, is suspended by a fine wire and is moved by a coil of fine wire suspended by a fiber between the poles of a powerful compound permanent magnet as in a reflecting galvanometer. The coil has a stationary magnetic soft-iron core which is magnetized by induction and strengthens the magnetic field of the permanent magnet.

The local current passes through the wave-detector and the suspended coil of wire when it swings in either direction according to the strength of the current impressed upon it; this moves the siphon, the upward strokes recording dots and the downward movements dashes.

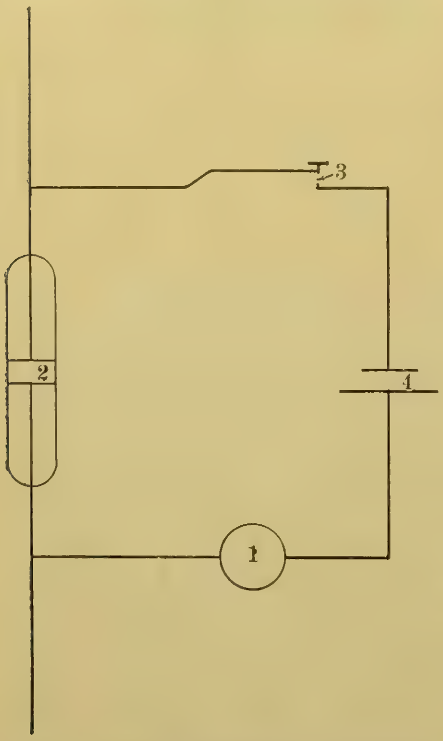


FIG. 35. METAMORPHOSED WIRELESS-TELEGRAPH RECEPTOR.

The telephone receiver, owing to its extraordinary sensitiveness, has been adopted by de Forest and Fessenden in their regular wireless receptors and by Braun-Siemens & Halske and Slaby-Arco in their field equipments. Owing to its simplicity, permanency of adjustment, and speed of operation, it is especially applicable to wireless-telegraph work in connection with auto-detectors. The code is read by the sharp clicks of the diaphragm; as in the ordinary telegraph sounder, it has two characteristic sounds, the first when the current is made and the second when the circuit is broken. With a telephone receiver 1, and an auto-coherer 2 connected as shown in Figure 35 the metamorphosis of the wireless-telegraph receptor is complete, and a simple, sure, and speedy instrument is the final result.

A STREET IN POCAHONTAS.

SOCIAL AND INDUSTRIAL CONDITIONS IN THE POCAHONTAS COAL FIELDS.

By Geo. L. Fowler.

In a preceding paper Mr. Fowler reviewed the physical and mechanical features of the Pocahontas mines. The present article rakes up the economic aspects of the industry—especially the condition and earnings of the miners. These are particularly interesting because in coal mining the wage of the employee is a more than usually direct function of the market price of the product.—THE EDITORS.

IN reviewing the Pocahontas coal region, as with any other great industry, it would be possible to prove almost any case, even the most extreme, by taking isolated examples and treating them as typical of the whole, a course that I shall attempt most carefully to avoid. The conditions presented by this industry are peculiar in one respect at least, in that it contains an element widely considered a problem of national importance, though those brought most intimately into contact with it regard the matter as local and beyond the province of interference by outsiders. This is the so-called negro question. If, therefore, it is given a position of some prominence in the discussion, it is because it is of the greatest importance to the region and is closely associated not only with the history of its past development, but with such growth as may be brought about in the future.

A COKE DRAWER.

Beyond this great question there are the minor ones of the physical conditions surrounding the home life of the people, the wages it is possible to earn, the regard for law and order prevalent in the community, the influence of the companies upon the life of the people, the character of the laborer, and the cost of living. No attempt will be made to treat these items under separate headings, as they are too intimately interwoven to admit of complete separation, but the subject will be handled in a way to bring them each and all into the light.

Here, as elsewhere throughout the south, the negro is the predominating figure, and we find him employed in all grades of labor where cool judgment, high personal responsibility, or reliability are not required. There is a wonderful degree of unanimity amongst all classes of employers as to his character, and this extends to all, whether they originally come from the north or the south. In the Pocahontas fields the managers and owners are nearly all from the north, many coming from Pennsylvania and Ohio, and there could hardly be one word of dispute between them and the greatest Southerner of them all in regard to the worth of the negro. First of all, they reiterate Miss Ophelia's opinion of his shiftlessness, adding thereto the belief that he belongs to an inferior race—that he ordinarily matures in early manhood and does not grow after that time. In short, that he is a child in his actions and ways of thinking, and is an adult in physical strength only. At the same time he is keenly alive to his rights, and promptly quits work the moment he feels that he is being imposed upon.

This condition of undeveloped mentality or childishness displays itself especially in the uneasy desire to be on the move and to seek for a different environment, though it may be but temporary. It is especially displayed by the desire to ride on the cars, and though there is no reason on earth for it, he is everlastingly on the move. This is most curiously exemplified by the fact that the one place in the region where it is possible and easy to hold the negro laborer, is the work train. He will stick to this with a persistency that is truly admirable, apparently for the reason that the periods of hard labor are interrupted at frequent intervals by rides on the cars. If, in addition to this, the railroad company will run a train or car to take him to town on Saturday night, the labor problem, as far as the work train is concerned, is solved.

Pay day invariably sees an exodus, and so long as there is any money in the pocket and the stomach is full it is very difficult to allure or force him back to his work. As his standard of living is very low, and as wages are comparatively high, three days in the week is quite sufficient to enable most of his class to live, and this is about all that they care to work, though perhaps below the average. The result is that all through the coal fields many more men are kept upon the pay rolls than are required to do the work, because of the constant defections that occur as the result of a full stomach and pay day.

Closely associated with the shiftlessness, and indeed a part of it, is the apparent inability of the negro to bear any burden of responsibility. This is recognized everywhere, with the result that negroes are not trusted in positions where judgment is required. As one example of the small details into which this extends, it is desired to keep a record of the charging of each individual coke oven. As the charging lorrey starts down the line it is weighed, and on its return the driver is expected to give to the weighmaster the number of the oven into which it was dumped. It has been found to be al-

WHITE MINERS' CHILDREN, POCAHONTAS.

most impossible to get the ordinary negro to give the correct number. He will say anything that comes into his head, and his inaccuracies render the record useless, simply because of his failure to remember the number that has been given him. This unreliability manifests itself in every way, and among the most annoying is in the use of kerosene in the open miner's lamp.

As the safety lamp is not needed in the Pocahontas mines, the open flame is used. The law, however, does require that miners' oil (a mixture of cotton-seed and lard oil) be used. It is almost impossible to prevent the men from adulterating this with kerosene, on account of the saving in cost, much to the detriment of the ventilation and to the increase of the danger of the work. In fact, it is the universal testimony of employers in all sections of the country, that the most persistent and flagrant violators of the laws enacted for their comfort and protection are the miners themselves.

For these reasons the negro is not placed in such positions of responsibility as locomotive-engine driving and the like.

The rivals of the negro in this field of labor are the Hungarians and Italians. They differ from him not in a higher standard of living, but in the thriftiness of saving. There is a constant flow of money orders from points where they are employed to Hungarian and Italian bankers in New York, as well as to friends and relatives abroad. This thriftiness extends to their work, and they are not only willing and anxious to work every day in the week, but discontent soon shows itself if they are unable to do so. One operator informed me that he thought the average Italian would save 80 per cent. of his earnings, and the postmaster at Gary told me that in the first three days after the establishment of a money-order office at that place, he issued five hundred orders drawn on New York and abroad, and that for weeks he was out of blanks most of the time because they could not be obtained as rapidly as they were called for.

As yet the Italians are not employed as miners, but there are numbers of Hungarians so engaged who have been brought down from Pennsylvania. The proportion of white miners to the whole is about 15 per cent. Hungarians, and an equal number of natives from West Virginia, Virginia, and North Carolina.

The last class belonging in the field of labor in the region are the natives. They are so few, however, as to exert no appreciable influence in one way or another. They make good woodsmen and guides, but their shiftless methods of living have not accustomed them to continuous and sustained labor and very little suffices. In short, they resemble the negro in their desire for frequent periods or "laying off." They are better than the mountain whites, who are forlorn and miserable in appearance and behavior; but, never having known or dreamed of anything better than the wretched surroundings of their everyday life, they are supremely unconscious of their own misery. How these mountaineers live or eke out an existence on their wretched farms is a mystery difficult to understand, while their lives of isolation among the steep gullies must partake strongly of the nature of utter desolation, since the country is undeveloped in the extreme, the roads are little better than bridle paths, and all intercommunication, save on the railroad, is by foot or horseback.

A CHARACTERISTIC GROUP OF MINERS IN THE POCAHONTAS FIELD.

With a community made up of such characters, and a population that might almost be called floating, it has been impossible, thus far, for the labor organizations to obtain a foothold. To be sure, there have been very strenuous exertions on the part of the owners to keep them out, and up to the present they have been successful; it is probable they will continue to be so, for many of the miners living in the field are at all times in close contact with their employers, so that when labor organizers make their appearance, and attempt to turn employees against their employers by making false statements, they are rarely successful, for the reason that the former's long knowledge of the latter enables him to detect the falsity at once. Then there is the fur-

A STREET IN GARY—A VIRGINIA COAL-MINING TOWN.

ther bar that in other States the unions will not permit the negro to join. As he is thoroughly well acquainted with this fact and with the conditions existing in Ohio, Indiana, and Illinois, he has no inclination, but rather an aversion, to joining a union.

As to the educational standard of the community as a whole, it would be regarded as low from the viewpoint of the more densely settled communities of the north. Graded schools are rare and will probably continue to be so, as the sparsity of population, except at a few points, will not permit of their existence. In some places the companies have provided good schools, and the period of school term has been increased from four months, as it was in the early days of the field, to nine months a year. As would naturally be supposed, the general sentiment of the people is not clamorous for educational advantages; and this, coupled with their low mental calibre, serves as a check to any marked elevation of public intelligence, though absolute illiteracy is almost unknown and there are exceptional cases of a high degree of mental brightness.

With such elements forming the basis of society and having a mere sprinkling of managers, clerks, and foremen to form only an insignificant minority, the standard of the community in some respects is decidedly low and the respect for law and order seems, at times, almost to disappear—though probably it is no worse than among the same classes in the cities. Here, however, nothing is hidden. Everything is done openly; and yet, on the whole, the villages that cluster about the mines are as quiet and orderly as one in New England, and a stranger as free from molestation. But among the negroes there is a suspicion of one another and a quarrelsomeness when slightly under the influence of liquor that renders them decidedly dangerous. A large majority of them go armed with revolvers, and their appreciation of a good weapon is such that the best is none too good; $16 and $20 are commonly paid for them, while the swell occasionally carries a fancy gold-mounted affair costing much more.

The danger to the white in such a community lies in accidentally crossing the path of a semi-intoxicated negro, whom liquor makes surly and quarrelsome and imbues with a false courage and a desire to display it. Such a man is to be avoided, as the chances are that he is armed and will not hesitate to use his revolver if he is provoked.

The other precaution to be taken is to keep away from their quarrels. These usually arise over a game of craps or cards or some trivial dispute, resulting in a shooting that frequently ends in the death of one or both parties to the affair. When such an event does take place, the onlookers scurry away like rats into their holes and the victim is left where he has fallen, until he is found by the whites or the

THE TOWN OF POCAHONTAS.

authorities. Formerly nothing would have been said about such a case, and an investigation would have been almost hopeless on account of the difficulty of locating the spectators. In fact, a few years ago such an affair would have been regarded as too insignificant to be reported and the victim would have been buried as a fitting end to the matter; but, now, an attempt is invariably made to arrest the criminal, though this is frequently of the greatest difficulty on account of the nearness of the State line and the possibility of escaping into the mountains where it is exceedingly difficult to follow. And yet, despite such a state of affairs, the stranger or the white has nothing to fear so long as he does not interfere in their quarrels or subject himself to a possible hold-up by straying into low haunts at night. There is no trouble in the community from robberies, burglaries, or hold-ups, and this class of crime is practically unknown. In short, it may be summed up as an exceedingly rough but by no means dangerous community.

Of course the sustaining element of the whole region is the coal company, and it is too frequently held responsible for everything that is bad, while the leaven of good that is to be found is accredited to the efforts of the miners to better their condition. It is, perhaps, possible that greater exertion on the part of the controlling companies might ameliorate the existing conditions to a certain extent, but where such

A MINER'S HOUSE, SWITCHBACK, WEST VIRGINIA.

attempts have been made the discouragement has been very, very great, as will be shown later; and one who has been upon the ground is apt to reverse the usual judgment and attribute what of good there is to the companies and consider the evils to exist in spite of their best endeavors to prevent them.

A HOUSE FOR SINGLE MEN, AT ENNIS, IN THE WEST VIRGINIA COAL-MINING REGION.

At all times the companies make every effort to better the condition of their employees. At nearly every operation, there will be found one or more churches, to which help has always been given, both for the erection of the buildings and the support of the pastors.

Ordinarily the standard of living of a community is dependent upon the wage-earning capacity of the inhabitants. As this rises so do the morals of the people, but this seems to have had but little effect in the Pocahontas country. Under the ordinary normal conditions of business the wages it is possible to earn are higher than in many more highly developed places. The miner is paid by the car load, at the rate of about 85 cents for room work and 90 cents for entry work, and on this, if working steadily with eight-hour shifts, he can make more than $100 a month. The coke drawers receive 60 to 65 cents an oven and can pull three or four in seven hours, while the day laborer is paid $1.50 a day, and these are fair samples of the other grades. But, ow-

A MINE STORE IN THE POCAHONTAS REGION.

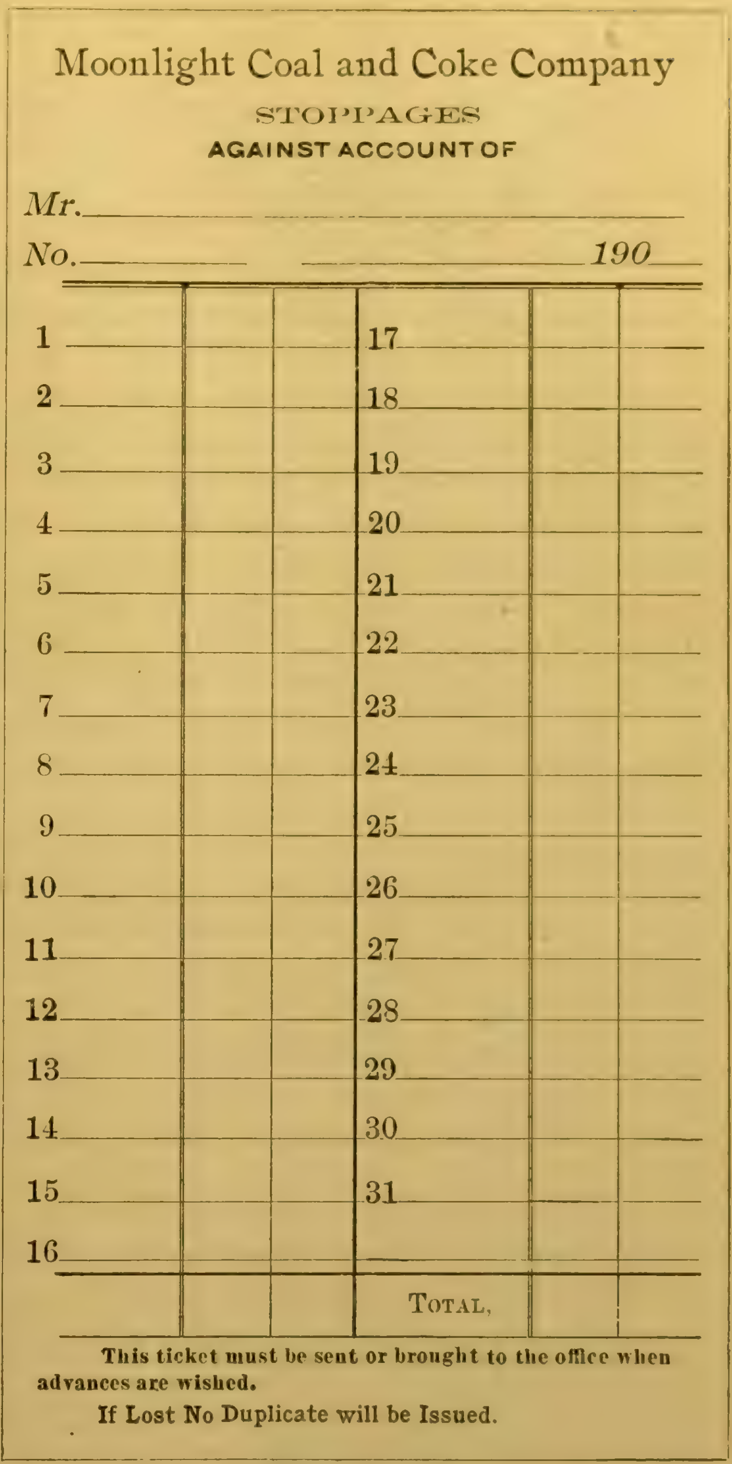
ing to the peculiar characteristics that have been detailed, these wages are not earned continuously. The miner runs from $60 to $70 a month; the coke drawer works three or four days in the week, and the rest in the same proportion; so that the actual wages received are low—much lower than they need be, and away below what the owners would like to see the individual earn.

Wages mean but little, however, unless the cost of living is taken into consideration, and with this comes in that familiar topic of the company store. To call it an unmitigated evil, as has been so frequently done, is absurd. To say that it is altogether good and above reproach would be something of a strain upon the truth; but to say that it is an absolute necessity, under existing conditions, is well within the mark. The character of the workman is such that he lives well up to the last cent of his earnings, and must needs ask for advances. His total disregard of all personal obligations would render it impossible for an outsider to do a credit business with him. This can only be done, therefore, by the employer, who knows at all times what is his due, and can limit or extend the credit advances accordingly.

The major portion of the wages are paid in company scrip in advance of pay day, and while the details of the method vary, the following example may be taken as fairly typical of the method in general use. On the first of the month the employee receives a card like the following, which is known as a stoppage card:—

The name and number of the employee and the month of issue are written at the top, and as scrip is issued from time to time on the presentation of the card, the amount is written in after the date of issue, so that both parties have a record of the amount at all times. The scrip is in denominations of $1.00, $2.00, $3.00, $4.00, $5.00, $6.00, $8.00 and $10.00 and is of the form shown on the following page.

The stub is retained by the cashier, and as the scrip is presented at the store the prices of the articles purchased in cents will be punched out on the margin until it is exhausted. These figures in the case illustrated will be found to foot up to $3.00. This scrip is sometimes issued in excess of the earnings of the employee, but usually it is limited to the amount of his credits. The method is very simple; the card is presented at the cashier's window and the amount desired named. This is issued and purchases made.



Moonlight Coal and Coke Company

STOPPAGES

AGAINST ACCOUNT OF

*Mr.*______________________________

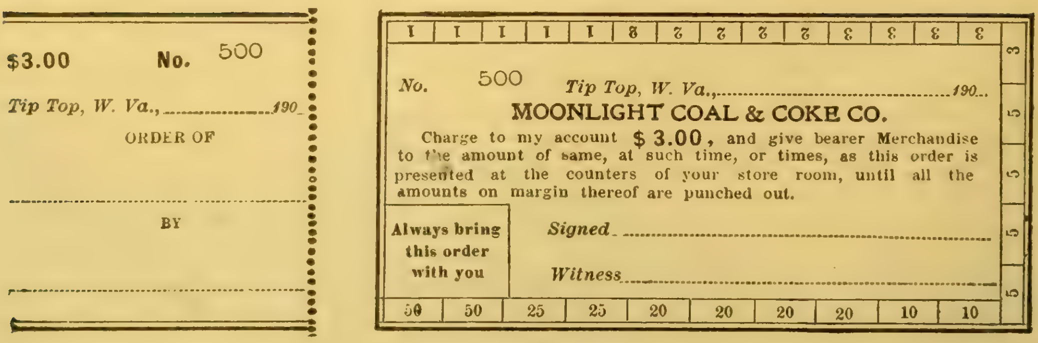
*No.*__________ ______________*190*____

1			17		
2			18		
3			19		
4			20		
5			21		
6			22		
7			23		
8			24		
9			25		
10			26		
11			27		
12			28		
13			29		
14			30		
15			31		
16					
			TOTAL,		

This ticket must be sent or brought to the office when advances are wished.

If Lost No Duplicate will be Issued.

STOPPAGE CARD.



$3.00 No. 500

Tip Top, W. Va.,............................*190*..

ORDER OF

BY

1	1	1	1	1	2	2	2	2	2	3	3	3	3	

No. 500 *Tip Top, W. Va.,*...*190*..

MOONLIGHT COAL & COKE CO.

Charge to my account $ 3.00, and give bearer Merchandise to the amount of same, at such time, or times, as this order is presented at the counters of your store room, until all the amounts on margin thereof are punched out.

Always bring this order with you

Signed..

Witness..

50	50	25	25	20	20	20	20	10	10

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COMPANY SCRIP.

So far there can be no objection to the method, but objectors find fault with the alleged compulsion upon the employee to trade at the company store, and that, too, at exorbitant prices. This is but partly true. That the employee at isolated mines is at times compelled to trade at the company store is true, as there is no other, for the very good reason already given. That the prices are exorbitant is not true, except in occasional instances. These depend upon the company. The large corporations do not run the mines for the benefit of the store. The latter is compelled to stand upon its own merits and to be able to meet any competition. There is no pretense that it is run as a partial charity, but no attempt is made to overcharge, and there is never the slightest effort to compel the employee to deal at the company store rather than elsewhere. The main inducement is that the prices at such stores are usually below those charged for the same grade of goods by outsiders—a condition rendered possible by the fact that purchases are made to the best possible advantage in large quantities, and only a fair profit added. In the case of some of the smaller companies, however, the prices are high, higher than the situation warrants; but the employee is rarely helpless in the matter; for, when such a condition exists, wagons from adjoining towns can be seen delivering goods from individual stores on their daily rounds. The main foothold, however, of the outside stores lies in the fact that such stores handle only an inferior class of goods, which being sold at a lower price, lead the workman to believe that there is an overcharge for those handled by the company.

In reviewing these conditions it is unfair to compare absolutely with those in more favored regions. It must be remembered that the field is isolated from the rest of the country, is a long distance from markets, that the freight charges are high, and that the country itself cannot raise the produce to support the inhabitants. The consequence is that prices are higher on many articles than they would be in New York, Philadelphia, or Pittsburg. This excess of charge is more apparent on luxuries. Necessities are usually reasonable, but cheap jewelry, fancy cravats, and the like, are apt to be high.

This much can be said of all classes of these stores—that the goods sold are of good quality and are what they are represented to be, and that they are conducted in a way to impress themselves upon one as being model business enterprises, in that they are invariably well housed and kept in the pink of neatness and order.

Closely associated with the company store in the meed of condemnation which it has received is the miner's house. Here it runs the whole gamut, from a mere shelter to a substantial and comfortable dwelling. Single men are apt to live in a shack of one room, substantially built to be sure, and capable of being kept warm and comfortable, but far from being an abode of luxury. Here the miner sleeps and possibly does his own cooking, though he frequently boards. For the married men, the three-room house is most common; it is usually well built and can be made comfortable, though its surroundings are far from attractive and are frequently dirty.

One of the largest companies operating the field erected very comfortable miners' and employees' houses, with the hope, though hardly the expectation, that they would lead to a higher standard of living among the men. Especial pains were taken with the three-room cottages. The rooms were fairly large, and in addition there was a small stove room with a flue, and a place to wash. It was expected that a small stove would be placed here, and that, when the miner returned from his work, his wife would have a fire and hot water ready for him; that he would wash, change his clothes, hang his working suit in this place, and then go to his living rooms a clean and comfortable man. This was of course, explained to the tenants, with results that were far from encouraging. A visit of the house inspector, shortly after the occupancy of the premises, showed that the families were practically living in one room; that the small wash room, from which it was expected so much comfort would be derived, was used by the children as a closet; that the other rooms than the living were used for similar purposes; that the open miner's lamp had been hung from a nail driven into the wall and had smoked the room black; and that the broad porch before the house had been fouled with slops and refuse. It may be added, however, that such a condition is by no means universal, and there are many of the miners' houses that are kept neat and clean. Here, as elsewhere, this is a personal matter, and it is solely in the hands of the individual as to whether his environment shall be clean or filthy. But, with the possibility of such treatment as that detailed staring them in the face, it is a small wonder that the companies are so loath to build better.

The rents charged for these houses average about $2.00 per room per month, though there are many one-room houses rented to single men for $1 a month.

In this connection it may be well to mention the list of charges that are carried against the men on the books as regular items. These are doctor, smithing, mine checks, and electric lights. For the company doctor the single men are charged 50 cents and the married men $1.00 a month, which pays for the privilege of summoning the doctor at any time, and for all medicine. A smithing charge of 50 cents a month is entered against every miner, and pays for the sharpening and dressing of his tools, with no extras. For the mine checks, or checks that the miner hangs upon the car, when loaded, a deposit of 10 cents each is required, which is refunded when the checks are returned. As many of the houses are fitted with electric lights, a charge is made for this dependent upon the number of lamps. A fairly average rate is 50 cents per month for one; $1.00 for two; $1.45 for three, and then rapidly decreasing until at $3.00 ten are supplied, after which the rate is 5 cents per lamp. Of course these latter rates do not affect the average miner and workman, who rarely has more than three.

In this review no attempt has been made to cite special instances of prosperity or misery, of lawlessness or upright living, of oppression or paternal care, but merely to give an idea of the average social conditions prevalent in the region and to show, in some measure, the reasons for the existence of these conditions as they are. From what has been said it will be seen that the place is no paradise, but that the necessities and comforts of life are well within the reach of the wage earner, if he can only be prevailed upon to take advantage of his opportunities. Unfortunately for him and for all concerned, his standard of living is low, and it will take time to educate him out of his present methods. Sanguine observers hope for an improvement in the Hungarian and Italian in a generation, but they doubt if the negro will show much improvement in less than three or four. At present the region is rough but not dangerous, and in this respect is constantly improving through the unceasing vigilance of the companies. It can never become a prosperous farming community on account of the roughness of the country, but that it might be made attractive to tourists is more than probable, through an improvement in the present wretched hotel accommodations; for certainly one would travel far before a more beautiful place could be found than this.

SYSTEMS AND METHODS OF MECHANICAL REFRIGERATION.

By Sterling H. Bunnell.

THE refrigerating machine, of whatever type, is nothing else than a reversed heat engine. Its cycle consists of the compression of a suitable medium, the removal of the consequent increase of sensible heat by circulating water, and the reception of heat by the cooled medium under a reduced pressure and corresponding low temperature, from the relatively cold body to be refrigerated.

This cycle is the basis of all mechanical refrigerating devices. The refrigerating medium may be a "permanent" or not conveniently liquefiable gas, or any of the fluids more readily changed between liquid and gaseous states. Since fluids of the latter class, by reason of the phenomena of latent heat, are able to take up during evaporation much greater quantities of heat per pound of gas handled than non-liquefiable gases can during mere expansion, much smaller quantities of the liquefiable refrigerants need be compressed per heat unit to be removed from the refrigerator. Aside from mechanical and other practical losses, all liquefiable gases work with equal efficiency in refrigerating machines, so that the selection of the best medium depends entirely on practical considerations.

Motors on the principle of the steam engine have been constructed to operate with various vapors, such as naphtha, alcohol, and even carbonic-acid gas. Refrigerating machines as well can be operated with any of a number of media, of which the most suitable are water, ether, methyl chloride, sulphur dioxide, "Pictet fluid," (a mixture of sulphur and carbon dioxides,) anhydrous ammonia, and carbon dioxide. The ideal refrigerant should liquefy at convenient temperatures under moderate pressures, and evaporate at suitable refrigerating temperatures at pressures not too low to allow of easy compression of the gas by single-stage cylinders back to the liquefying pressure, and besides should be neither inflammable, explosive, chemically active upon common metals, dangerous to life or property in case of leakage or accidental escape from the apparatus, nor expensive to purchase. In the case of the steam engine, water is so much the best working medium that others have been used only to a limited extent in motors for special purposes. The reversed heat engine is reversed in this particular as well, for water is in practice the most uneconomical of refrigerants, while no other substance is universally agreed to be the best.

The compression process may be broadly said to cover all the systems of refrigeration by mechanical means. The apparatus comprises a compressor, a condenser in which the compressed and heated refrigerant is brought into the liquid state by cooling with circulating water, and a set of expansion coils in which the liquid refrigerating medium is allowed to expand under a low pressure and corresponding temperature and derive the necessary heat for its evaporation from the surrounding substances to be cooled. The dimensions and details of compressor and piping may differ with the gas used, but the principles are identical. Most common and some rare fluids have been considered with a view to service as refrigerants, and many have been actually tried; but only about half a dozen have been commercially used and exploited by manufacturers. Ether and some other volatile substances evaporating under atmospheric pressure, particularly in a current of air, at freezing temperatures, suggested the artificial production of ice and were the subjects of the earliest experiments. As the theory was developed the advantage of denser mediums became apparent, and refrigerating pressures rose with steam pressures, as other fluids were tried, until today one widely-used system carries without difficulty pressures sometimes higher than one thousand pounds to the square inch. It is convenient to consider the systems in the order of the condensing pressures carried.

First in this classification is water vapor, the medium of the so-called "vacuum ice machine." An air-tight chamber provided with a removable cover is exhausted by an air pump—a compressor—to a pressure below .089 pounds per square inch absolute. Water is introduced into the chamber in a spray, and part evaporates under reduced temperature, the vapor being continually pumped away, until in supplying the latent heat necessary for the evaporation the remainder of the water forms ice. When a sufficient quantity has formed the chamber is opened and the ice cake removed, after which the process is commenced as before. The theoretical capacity of the compressor is 866,580 cubic feet per ton of ice formed, and as this great volume of vapor is compressed under an extremely light pressure, the mechanical efficiency is very low. The duty is much improved by compressing the vapor to 1½ pounds per square inch absolute and then condensing it as with steam engines, instead of delivering it as vapor under atmospheric pressure. Another way is to absorb the vapor in sulphuric acid, treating the acid to remove the dissolved water and using it over and over.

These machines are not in commercial use and thus far have not attracted the attention of purchasers. The obstacles heretofore insurmountable are the impossibility of making transparent ice, the minute quantity of dissolved air expanding under the reduction of pressure and forming very objectionable bubbles; the difficulty of making satisfactorily air-tight joints at the covers of the evaporators and elsewhere; and the inefficiency of compressors handling air at extremely low pressures, or the complications and manifest objections introduced with the sulphuric-acid system.

Next in order to this direct method come systems using gases liquefiable at pressures not unlike those of the steam engines contemporary with these machines. Ether was the favorite with inventors working in the period from 1834 to 1865; naphtha, chimogene, carbon bisulphide, methylic ether, and possibly some others were subjects of later experiments. At refrigerating temperatures all these liquids evaporate at pressures below atmospheric, so that any leakage causes the introduction either of air, with consequent disturbance to the condensing process, or of water or brine, which is likely to make trouble in other ways. The gases are subject to chemical dissociation under heat and pressure, or in combination with water leaking into the pipes may form other chemical compounds; while some of them are inflammable, poisonous, or corrosive. Finally, such tenuous gases require excessive cylinder capacity in the compressor, and must be worked under high ratios of compression with all the attendant mechanical difficulties and inefficiency. For these and other reasons the art has advanced to the use of gases requiring higher pressures.

Modern practice accordingly employs such media as sulphur and carbon dioxides and the Pictet mixture of the two, anhydrous ammonia, and even common air. Sulphur dioxide was put into practical use by Pictet in 1876, and is the preferred medium of several prominent European builders, though never extensively employed in America. It has no chemical affinity for metals or oils, is incombustible, cheap, and a fair lubricant. At ordinary temperature the condensing pressure is under 60 pounds per square inch, and the required evaporating pressure is somewhat below atmospheric. Leakage in submerged expansion coils therefore permits the entrance of water and the formation of sulphuric acid, with resulting rapid destruction of the apparatus. In the effort to improve the efficiency of his machine Pictet invented the mixture of 97 per cent. sulphur dioxide and 3 per cent. carbon dioxide, known as "Pictet fluid" and used by several

Continental manufacturers. As used for refrigeration this compound does not follow the law of perfect gases, having evaporating pressures higher at refrigerating temperatures and lower at condensing temperatures than sulphur dioxide alone. Greater efficiency is claimed in accordance with this peculiar behavior, and explained by the theory of a chemical combination between the mixed gases under condensing pressure and a corresponding dissociation under low temperature and pressure. There is not enough positive information for discussion of this theory. The few recorded tests show inconsiderable differences between this combination and sulphur dioxide alone.

At present, the majority of refrigerating machines employ as their medium anhydrous ammonia. The condensing pressure required with this gas is from 150 to 200 pounds per square inch, and the evaporating pressure from 15 pounds upward above the atmospheric. The ratio of compression is thus six or eight to one, almost enough to make two-stage compression desirable, and requiring for single stage operation particular care in designing valves, cylinder, and piston so as to minimize clearance losses and leakage. Ammonia is in many ways an ideal refrigerating medium, being cheap, efficient, and chemically stable. But its chemical activity prevents the use of copper, zinc, and brass for pipes or fittings, and compels making all apparatus of iron or steel exclusively. The superior heat-conducting power of copper and its alloys, and their durability under the action of water and moist air, particularly at sea, cannot be secured in a machine using anhydrous ammonia. The odorous and poisonous nature of ammonia gas is very unfortunate, since any slight derangement or accident causing leakage produces an atmosphere in which men cannot live, except when protected by diver's helmets or similar apparatus, destroys any food products which may be reached by the odor, and permeates the walls and casings so as to require an expensive process of ventilation, disinfecting, and repainting. Accident to an ammonia apparatus is usually followed by the flight of every person in the building and immediate vicinity, and too often by the death of the men at work near the leak or escape. Fires in cold-storage plants generally cannot be checked before serious damage is done, because the firemen know that the first falling pipe will spread the deadly gas everywhere and cause the death of all who are not in a position to flee instantly. Ammonia escaping during a conflagration is inflammable and may even be explosive, though under other conditions it seems to have a tendency to extinguish fire. Safety valves to relieve excessive pressure being inadmissible, the best insurance against accident lies in providing a great margin of strength.

When ammonia refrigerating machinery is used on shipboard, approved practice provides for the plant a separate compartment and force of engineers—an inconvenient arrangement which only mitigates the dangerous results of accident, and adds another argument in favor of the safe carbonic-anhydride or compressed-air machines.

The prevention of odor about the apparatus being then the great difficulty, the designer of ammonia machinery must produce an apparatus able to hold 200-pounds gas pressure without perceptible leakage. To prevent ammonia odor at stuffing boxes, some makers build single-acting cylinders, so as to carry a low pressure on the packing; others provide an oil-seal, and others enclose single-acting cylinders, pistons, cranks, and shaft in a hollow case and provide packing around the crankshaft only. Stuffing-boxes are always made extremely long, and the packing sometimes comprises a sleeve or lantern supplied with oil under pressure. Variation in the amount of liquid present in the gas coming from the evaporating pipes causes change in temperature and tension of packing, so that glands may need frequent attention. These problems have been variously solved, but even yet freedom from objectionable odor from machines operated in or near rooms occupied by men is at the cost of much expense and attention from the operators. There is usually some loss of ammonia not traceable to perceptible leakage, due to overheating during compression and consequent chemical action between ammonia and lubricating oil, resulting in the formation of permanent gases in the condenser and the loss of the ammonia thus transformed by the necessary blowing-off; this waste with that due to necessary blowing-off to clear foreign matter from coils often runs as high as one charge of ammonia in a year.

Anhydrous ammonia is used in another system, performing refrigerating work in the same way, but avoiding mechanical compression of the gas by use of the principles of chemical solution. This, the absorption system of Carré, is next to the ammonia-compression system in number in use, and has certain special advantages that will be set forth. The system involves condenser and evaporating coil, as with the compression type, but in place of the compressor is an absorber in which a weak solution of ammonia in water takes up the ammonia gas from the evaporator. From the absorber the strengthened solution is passed through an interchanger to the still, where continuous application of heat drives off the ammonia under pressure, the gas passing to the condenser as with the other system, and the liquid, now hot and again a weak solution, being returned through the interchanger to the absorber. The office of the interchanger is to transfer heat from the weak, hot liquid to the strong, cold solution coming from the absorber. Much of the heat expended upon the solution in the process of driving off the gas is thus saved and used in warming the next portion to be treated. To do its best work the absorption system requires more cooling water than other methods, which is in some cases an objection to its use.

The only moving machine required in the absorption apparatus is the small pump which transfers the strong liquid from absorber to still against the condensing pressure of the ammonia. As the degree of heat required for the still is not great, exhaust steam may be used for heating and for running the pump, and the absorption refrigerating apparatus may be thus installed alongside steam engines and operated at extremely low cost. In modern hotels and office buildings quiet is essential and exhaust steam plentiful, so that the absorption refrigerating machines fits well into such places.

The special disadvantages of this system are, first, the objections to ammonia in itself, already enumerated, and second, the difficulty of operation and maintenance. For instance, too much heat at the still drives water over with the ammonia, similarly to the priming of a forced steam boiler, and may force out the weak liquor too rapidly and lower the level in the still. In the first case, ice will be formed in the refrigerator coils and choke or close them; and in the second, the working conditions of the plant will be disturbed and much care must be given to restore them. Deterioration goes on more rapidly than with anhydrous ammonia, so that the apparatus needs overhauling at frequent intervals.

Progress seems to have been in the direction of increasing pressures of gas, with corresponding increased density and decreased cylinder volume in the compressor. The step from sulphur dioxide at 60 pounds to ammonia at 180 to 200 involved the exchange of a distinctively low pressure for one considered decidedly formidable, even for the comparatively harmless steam, and necessarily much more so for a dangerous gas such as ammonia, where no simple safety valve can be used. The next step was a long one in the matter of pressure, but justified by the fact that the refrigerating medium thus put in use, unlike steam and ammonia, is entirely harmless. Of the cheap and common gases carbonic anhydride comes next to ammonia in condensing pressure, but with the formidable figure of 800 to 1,200 pounds per square inch under ordinary temperature conditions. Otherwise the gas is absolutely ideal, being dense, odorless, practically harmless, cheap, chemically inert, and low as to its freezing point. These marked advantages induced the original designers to attempt the development of means to cope with the heavy pressures, and the result has been perhaps the most promising system of refrigeration now in use.

Most works on refrigeration dismiss the carbonic-anhydride system with a brief mention of a well-known English manufacturer and a vague allusion to other foreign constructors not named. It is true that European manufacturers took up the manufacture of the carbonic anhydride apparatus several years before its development was begun in the United States; but there are now three or more American shops offering these machines, while the total number in use throughout the world is probably over two thousand. The majority of these plants are on shipboard, but their use for cold-storage work on land is being rapidly extended.

The carbonic-anhydride refrigerating apparatus must be constructed primarily for strength, but the smaller size of pipes and cylinders required compensates for greater proportionate thickness by keeping down the total weight and space occupied, considerably to the advantage of this system. The absolute tightness of the pipe system is easily secured by metal gaskets in strong flanged joints. The piston-rod packing presents the only chance for possible leakage, and its tightness is insured by the use of cup-leather packings sealed by oil supplied under pressure by a small pump and accumulator cylinder. The oil pressure is maintained somewhat higher than the maximum gas pressure in the cylinder, so that leakage may take place into the cylinder from the oil chamber rather than outward from the gas in the cylinder to the atmosphere. One patented arrangement provides a compound packing, the interior cup leather being placed just beyond a gas chamber, through which any gas escaping from the cylinder past the leather may return to the suction side of the machine; and the usual oil-chamber with its cup leathers is provided outside the gas-intercepting space, where only the suction pressure has to be held, instead of the entire discharge pressure as in the case of the usual single packing. As carbonic anhydride is inert, copper and bronze are used wherever convenient, a great advantage in producing a non-corrosive and almost indestructible apparatus, particularly where sea water is used for condensing purposes.

Carbonic anhydride is permanent under all conditions of a refrigerating apparatus, and will neither dissociate nor combine with oil or any other substances used about the plant. The pure gas as used by bottlers, unlike the exhaled product of animal respiration, is entirely harmless as well as odorless, and while it will not support life, it is absolutely inappreciable in its effects, even if liberated in quantity in an ordinary closed room. In addition to other desirable qualities is its value as a fire extinguisher. The ratio of compression in carbonic-anhydride machines is very low—only two or four to one—and therefore very much in favor of economical performance of the compression part of the cycle, as compared with the inferior efficiency of machines of other systems operating under a much greater ratio.

It should here be noted that all liquefiable-gas systems suffer a loss of useful refrigerating effect by the cooling of the liquid from the condensing to the evaporating temperature. The condensed gas leaving the condenser at, say, 70° must be itself cooled to the evaporating temperature immediately after passing the expansion valve as the evaporation commences, and the heat thus given up by the liquid diminishes the useful effect of the evaporation in cooling the desired substances around the pipes. The loss of efficiency could be avoided by evaporating the liquid in part and doing work on a piston, the heat given up being thereby converted into work; but this would introduce a complication not warranted by the very small saving possible. As carbonic anhydride in the liquid state has a density and specific heat much greater than those of other gases used for refrigeration, the loss in this system from the cooling of the liquid is greater than in the others; but it is more than compensated by the superior efficiency of the compression process, with the dense gas and low ratio.

Last in order of liquefying pressures comes air. Liquid air when first produced on a large scale was claimed to possess superior refrigerating value, but figures soon showed that no such enormous quantity of refrigerating effect as alleged could be stored up in small compass, and the impossibility of liquefying the air by natural cooling without expensive mechanical processes disposed of the project. Common air is, however, used in refrigeration by simple compression, cooling, and subsequent expansion doing work against a piston, the latter process being required to dispose of the heat carried by the air, by converting it into mechanical work. In the earlier method, atmospheric air from the storage rooms was compressed to about 65 pounds per square inch, the resulting sensible heat being removed by circulating water, and then expanded to atmospheric pressure against a piston connected to the mechanism so as to return the work so developed to the apparatus. The air leaving the expansion cylinder at a temperature of 60° to 80° below zero was then led through the "snow box" in which the moisture carried thus far was deposited, the latent heat liberated by the vapor in the process of condensation and freezing raising the temperature of the air 20 to 60 degrees in passing the length of the snow box. This rise in temperature without useful effect was to the enormous disadvantage of the process, being about one-fourth to one-half of the total possible range of temperature from the minimum in the expansion cylinder to the cold-storage temperature to be produced.

By confining a quantity of air and working it in a closed cycle, the moisture once deposited would be finally eliminated instead of being replaced by evaporation from articles within storage rooms, as in the first method. The resulting gain in efficiency could be greatly increased by raising the pressures under which the confined air should be worked. This process constitutes the "dense-air" system of refrigeration, and is extensively used on shipboard. As compared with the simple compression machine using liquefiable gas, the dense-air apparatus seems complicated, requiring one compressing, one expanding, and one make-up cylinder (to replace leakage) besides the power (usually a steam) cylinder. The lack of the effective latent-heat principle causes the refrigerating effect per cubic foot of cylinder displacement to be very small compared with the liquefiable gas process, so that in comparison the several cylinders must be very large for equal refrigerating capacity, and the weight and space occupied is excessive, while the efficiency is low. For these reasons the air machine is only advocated for use on ships where its independence of a reserve supply of any special chemical and its use of a harmless refrigerant are of advantage. The low-pressure air machine is no longer built, having been entirely superseded by the dense-air type.

Summarizing the three refrigerants in common use, ammonia is seen to have good efficiency and moderate pressure, but most dangerous effects in case of accidental escape; air, very low efficiency and excessive weight, bulk, and complication of apparatus, but moderate pressure and entire absence of objectionable qualities in the refrigerant itself; while carbonic anhydride affords an efficiency slightly superior under ordinary conditions to that of the ammonia system, pressures (while the highest of any common refrigerant) by no means so high as to be unmanageable or dangerous, and at the same time the lightest and most compact of machinery, made with non-corrosive metals wherever desirable, and these with a gas that is readily and cheaply obtained in all important cities of the world and is entirely harmless under any conditions of use, misuse, or neglect. Assuming that carbonic anhydride has no advantage over anhydrous ammonia in respect to first cost of apparatus, power, weight, and space occupied, and that the expense of replacing leakage is as great—all of which conditions seem in practice to work out more or less in favor of the former refrigerant—the carbonic-anhydride system insures maximum safety to men and materials in the neighborhood, under no matter how serious an accident or emergency, while the presence of ammonia under pressure is a constant menace to operators and stored property alike.

Passing from the development of the refrigeration to its application, the methods used are found to apply alike to all systems of refrigeration. The cooling of the metal expansion pipes by the evaporation of liquid therein is always the first effect produced. The pipes may be located in the rooms to be cooled, and transfer the effect to the air by conduction and convection—the direct-expansion method; or they may be submerged in water or a solution of sodium or calcium chloride, and this in turn circulated and used as a heat-carrying medium—the brine-circulation system. Sometimes the pipes are arranged in banks, either within the rooms or elsewhere, and air circulated through the rooms by fans or a central blower and system of ducts. By arranging a sufficient amount of cooling pipe and racks, meat or fish may be frozen solid and thus preserved indefinitely by storage at 10 to 15 degrees above zero Fahrenheit.

Small machines are used in cooling work rooms, offices, and candy factories, and might equally well be used in cooling living rooms in large summer residences. The cost of such cooling is generally supposed to be too high to be borne, except where, as in workrooms, substantial cash compensation obtainable in no other way can be had. A pound of coal used in steam-heating a room may deliver 8,000 to 10,000 B. T. U., but in refrigeration on a small scale may only remove 1,700 B. T. U.; so that if average winter weather requires heating a building 50 degrees and average summer weather requires cooling the room 10 degrees to a desired temperature of 70 degrees, it would cost no more for coal to cool in summer than to heat in winter. The necessary machinery would require more expensive attendance than a heater, and with a very small plant the duty would not reach 1,700 B. T. U. per pound of coal. The cooling of theaters and audience rooms is greatly to be desired, but as the heat emitted by the human body is about 400 B. T. U. per hour, enough to warm a crowded house in winter weather without the aid of a heating plant, the necessary refrigeration in hot summer weather would cost much more than the usual running expense of the heating apparatus in winter. Supposing the performance of cooling equal to the melting of 12 pounds of ice by each pound of coal burned, there would be required for each 1,000 persons a refrigerating capacity equal to the melting of 34 tons of ice in twenty-four hours, and requiring the consumption of 225 pounds of coal per hour. As the engineering problems are very simple, the comfortable theater may yet be the fact.

The other great field of mechanical refrigeration, the one for which the art was first developed, is the making of ice. There are now two principal systems, known as can and plate, the first freezing water contained in open cans of sheet iron floated in refrigerated brine, and the second forming ice in sheets on the sides of cooled metal plates immersed in water. Clear crystal ice being demanded by the market, the dissolved air which would form bubbles during freezing and make the ice white must be driven off, by simply agitating the water in cans or plate ice tanks through the medium of compressed air jets or agitating wheels, rarely by continually rocking all the cans by mechanism, or by previously distilling all the water used for making ice. The latter process insures the purity of the water and is regularly used with the can system, exhaust steam from the engine which operates the plant being condensed, filtered, and cooled for use in the ice cans. This does not mean that the economy of the best condensing engine can be obtained, since the water of condensation must be violently reboiled to remove the remaining air and drive off impurities, and is therefore condensed at 212° and under atmospheric pressure; in fact, to obtain the necessary one-fourth ton of water and the additional quantity lost in reboiling and skimming, steam to the amount of 5 or 6 pounds per horse-power hour must be provided and may as well go through the engine as be taken "live" from the boiler. When naturally pure water is at hand, the plate system is therefore preferred, steam being unnecessary for ice making, so that the machinery can be operated by an economical steam engine or by water or other power. The 300-pound cake of can ice is frozen in about forty-eight hours, whereas plate ice 11 inches thick is from ten days to two weeks in forming; which means that in the plate plant more than five times the quantity of water is in process of treatment, and the space and first cost is much greater than for the other system.

Ice cans are lifted one or more at a time by hand or power cranes, and either dipped or sprinkled with water until the ice cake slips out, in modern plants to slide without manual labor through an automatic door into the storage room, registering its passage on the way to tally the output of the plant. Plate ice is loosened by substituting either hot gas from the compressor for the liquid evaporating in the hollow metal plates (the resulting liquid being used in other parts of the plant with that produced in the regular condenser,) or substituting warm brine for cold brine where brine plates are used; or by cutting the slabs of ice free by mechanical saws or by small steam pipes which melt their way through the cakes. The loosened plates, weighing five to ten tons each, are lifted by a crane and subdivided by saws or steam cutters into marketable pieces. Plate ice is beautifully clear and transparent, while can ice, being formed of radiating crystals, is generally more or less translucent in the interior and has whatever air or impurities may be present concentrated at the center. The purifying apparatus of the can plant requires continual care to avoid rust, dirt, and defective operation, while the plate-plant engineer has the problem of freezing good corners and detaching the large brittle slabs without cracking them, and of managing to have the proper number of plates of full thickness ready each night for the next day's demand. With the best apparatus and competent workmen, the cost of manufacturing ice is less with the plate than with the can system.

Most of the ice manufactured is used in refrigerators, many of which could be profitably cooled by direct mechanical refrigeration. The use of small independent plants in markets, hotels, and saloons is rapidly increasing. In some thickly settled districts there are companies circulating cold brine through underground pipes in the streets to refrigerators in neighboring buildings, and doing a profitable business in spite of the heat loss through the pipe covering. It has been proposed to circulate some liquid refrigerant, returning the gas to the central station; but as leakage would be highly dangerous in case of ammonia, and expensive loss of gas practically certain to occur in inaccessible underground pipes under the pressure necessary with carbonic anhydride, the problem is as yet too difficult.

The cooling of refrigerator cars by ice at enormous expense and at the cost of valuable freight space is a wasteful and ineffectual method of preserving meat during transportation. Refrigerating machinery has been at last applied to this service, and lines of mechanically cooled cars will probably soon be in operation. The successful machine is carried under the car body, driven from one of the axles, and applied to freezing ice in narrow tanks by the carbonic-anhydride system. The condensing devices used on these cars are highly ingenious in detail, though the principle is the familiar one of evaporating on the surface of the condensing pipes part of the water from a small supply carried in a tank along the car roof.

Refrigerating and ice-making machines have already taken their place with steam engines as machines with well-known principles of design and construction, manufactured by various shops in nearly every state in the country. Their general sale and use has undoubtedly added very greatly to the general comfort and health, and decreased the cost of living, by providing means of preserving and transporting perishable food products.

WAGE-PAYING METHODS FROM THE VIEWPOINT OF INVESTED CAPITAL.

By Henry Hess.

With this article Mr. Hess concludes his very interesting graphic study of the effect of various wage systems, which began in our issue for April last. The object has been not to dogmatize, but to develop the facts. Comment from the authors of the various plans or from those who are using them will be cordially welcomed by Mr. Hess and by the editors of the Magazine.

IN the preceding chapters of this discussion (in this Magazine for April and May, 1904), the effect of various methods of wage payment on the workman's wage and on the profit and loss account was considered. The first paper dealt chiefly with the more immediately apparent interests of the workman who lends his services in return for as large a wage as he can secure; the second paper went into the question from the standpoint of the manager, standing between the workman and the capitalist; the latter's interests as affected by the wage cost under various methods of remuneration for enhanced speed of working, form the basis of this concluding chapter.

As it is clear that capital will favor that method which secures the highest interest return while employing the least total amount, the investigation is directed toward determining the relative value of the various wage-paying methods in this regard.

In order to avoid the difficulty of digestion of long columns and tables of figures, the graphic representation of results is made use of. While rates of pay and the relation of wages cost to material and expense vary decidedly in different industries, yet the general results will be similar, though the numerical values will vary. As a fairly general average for machine building a wage cost by day pay of 25 cents per hour, a general expense of 30 cents per hour, and a material cost of 40 cents per hour will answer, and have been taken; it has been further assumed that the product of one hour's work, under ordinary day pay and ordinary rate of production, is sold for $1.00.

Chart 6 (reproduced from the previous chapter) illustrates graphically the results for day pay. At the centre of the base scale 1 stands for one hour occupied; to the left of this are figures giving lesser amounts of time used, down to a saving of all the time at zero; to the

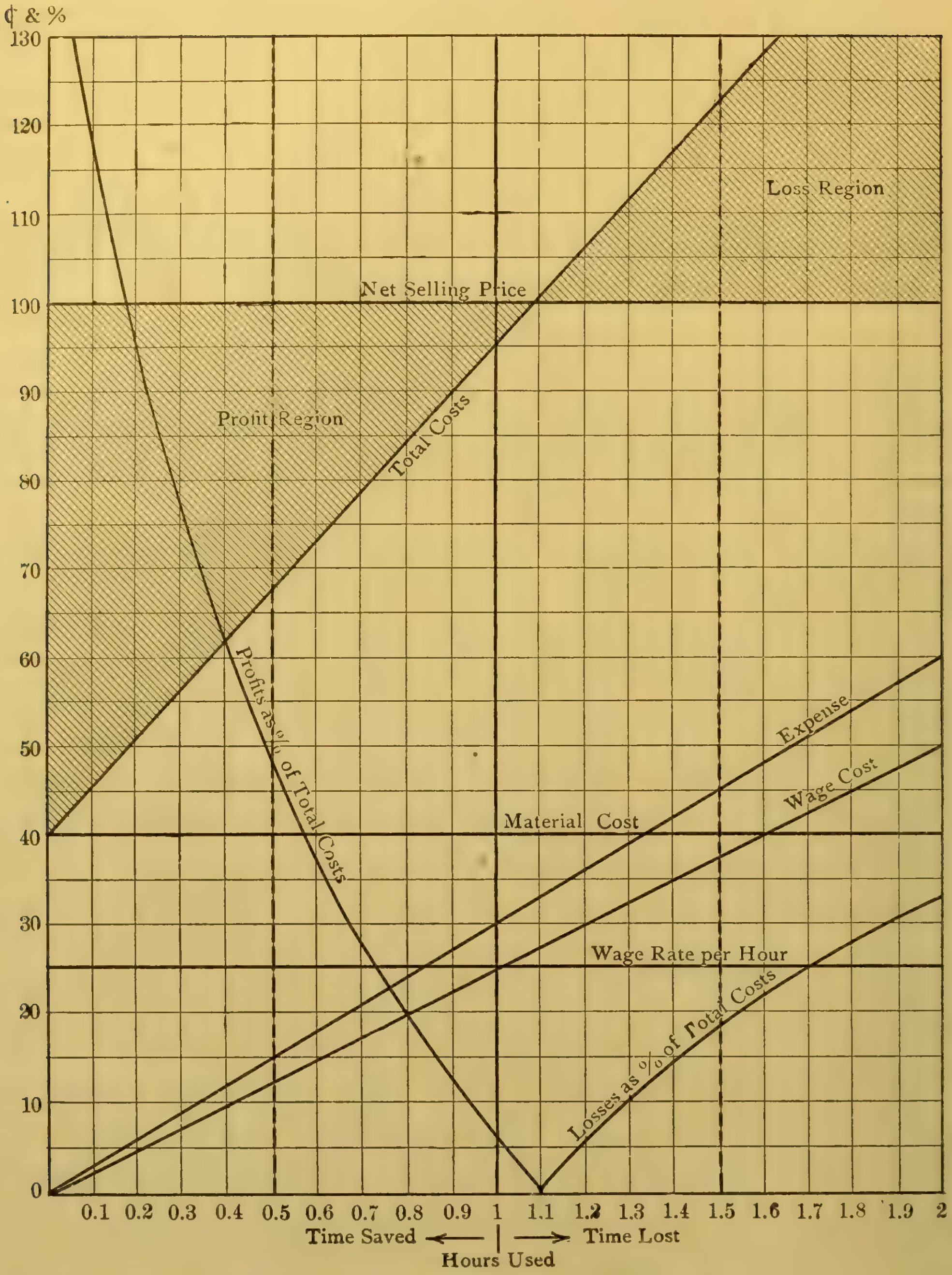

CHART 6. PROFIT AND LOSS BY DAY PAY.

right are figures giving the time used in excess of the one-hour basis, up to a maximum of two hours. The vertical scale at the left is marked in cents and per cent. Since with day pay the wage rate per hour is constant, the wage cost of the work will be proportional to the actual time used; a diagonal line starting from zero cost at zero time and laid through 25 cents at one hour will represent the wage cost for all possible time between zero and two hours; thus, tracing from 0.5 hours at the base scale vertically upward to intersection with the

"Wages Cost" line, and then referring to the scale at the left, gives a wage cost of 12.5 cents. A similar diagonal marked "Expense" gives the expense cost incurred for the time used. As material cost is constant for any piece of work and not variable with the time taken to do the work, it is represented by the horizontal line marked "Material Cost" at 40 cents. The total costs are found by summing up the three elements of wages, expense, and material cost, and are represented by the slant line starting from 40 cents at the left-hand scale and marked "Total Costs." As the selling price is fixed by general market conditions rather than by the varying individual manufacturer's cost, it will be represented by a horizontal line, in this case at 100 cents. So long as the total costs are less than this selling price, there will be a profit, indicated on the chart by the total-cost line lying below the selling-price line, while the amount of the profit is shown by the vertical distance between the two lines. Thus at 1 hour there is a profit of 5 cents; with only 0.5 hour taken this profit rises to 32.5 cents. Loss is indicated whenever the total-cost line rises above the selling-price line—in the example this occurs whenever more than 1.1 hours are occupied in doing the work.

Since invested capital reckons its returns on a yearly basis the results are to be considered for a year's work. The working year is made up of 300 days of 10 hours—3,000 working hours. At the base time of one hour, the year's total costs are 3,000 × 0.95 = $2,850. The year's returns at the net selling price of $1.00 for the basic hour's output is 3,000 × 1.00 = $3,000; the year's profit is, therefore, $3,000 — $2,850 = $150. The total capital actually employed is equal to the total cost of the year's product; the $150 then represent a profit on that capital of 5.3 per cent.*

Since time saving results in a saving of wages and expense cost, it is evident enough that such saving will be attended also by an increased interest return on the capital. At a saving of one-half the time, Chart 6 shows the profit on the job to be 32.5 cents; the profit on 3,000 jobs is 3,000 × 32.5 cents = $975; the total cost per job is 67.5 cents and the actually employed capital is, therefore, 3,000 × 67.5 cents = $2,025; as the work is completed in one-half the old time, this capital is employed only a half year and the interest returns therefore are $\frac{975 \times 100}{2,025} \times 2 = 96.3$ per cent. The profit returns

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* Whether or not this is correct depends upon the rate at which the detail costs are incurred and the way in which the sales returns come in. As the purpose of this investigation is comparative and since the assumption made above will not change relative values, that assumption is permissible.

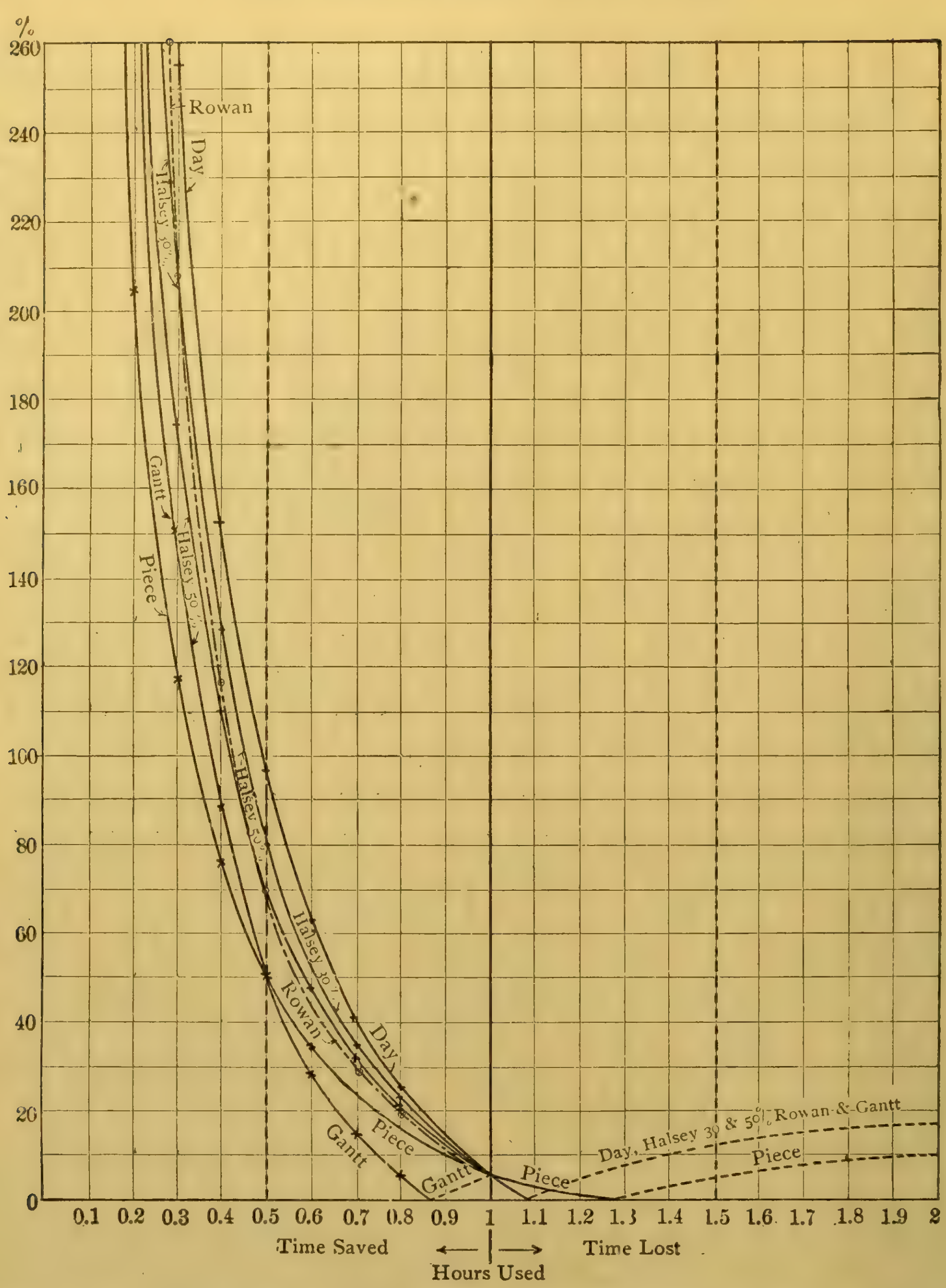

CHART 13. ANNUAL PROFIT AND LOSS, AS PERCENTAGE OF CAPITAL ACTUALLY EMPLOYED, BY TIME SAVINGS UNDER VARIOUS METHODS OF WAGE PAYMENT.

for various time savings are calculated similarly and then plotted on Chart 13; the characteristic line is the curve marked "Day Pay," in this chart; also, the lower scale refers to the time saved and the vertical scale to the per cent. of interest returns. Were it generally possible to induce men working by the day to exert themselves continuously so as to save time, then day pay must necesarily result in higher returns to invested capital than any other method of wage payment involving a sharing of the money value of the time saved. As that is, however, rarely possible, and in fact contrary to human nature, various methods have been devised having the common feature of an extra wage recompense for extra exertions.

Of these the most widely adopted is "Piece Work"; under its operation the entire wage-cost saving goes to the workman, while capital retains as its share the values in savings in general expense, and the enhanced earning capacity attendant on a more frequent turn-over.

A curve characteristic of piece work is plotted on Chart 13; its derivation is analogous to that explained for day pay; the elements are shown in Chart 10, page 184 of the May number of THE ENGINEERING MAGAZINE. A comparison of the curves on Chart 13 shows that the returns for piece work are decidedly less than with day pay throughout the region of time saved. On the other hand, since the day-pay curve return reaches zero at a time loss due to the occupation of 1.1 hours, and this point of no earnings is reached by piece work only after 1.27 hours are taken up, it is evident that piece work favors capital when time is lost; a comparison of the loss curves further confirms this conclusion. The reason is very simple; the piece worker shares in the loss attending time loss to the extent that such time loss reduces his wage rate; this is a logical corrollary to his sharing in the savings to the full extent that such time savings increase his wage rate and return.

Of the other systems, the Halsey premium plans share the wage-cost value of time savings between the employee and the employer in varying ratios; two arrangements are in very general use, of which one awards the workman 30 and the other 50 per cent. of the wage value of the time saved as a stimulus and reward for increased effort. A modified premium plan—the Rowan—so arranges the premium that the wage rate per hour is inversely proportional to the time saving, in such way that the wage return per hour would be exactly doubled if the time were reduced to zero. (See also page 31 of the April issue of THE ENGINEERING MAGAZINE.) The Gantt plan provides a very considerable bonus as a stimulus to the attainment of a time set as short as close study shows may be attained by a good man.

All of these plans, except piece work, assure the workman day pay when time is lost; hence the coincidence of their time-loss curves.

On Chart 13 curves characteristic of all these various plans are plotted.*

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* Charts, similar to number 6 for day pay, containing the elements for the various other wage-payment plans, are given on pages 172 to 186 of the preceding chapter in the May issue of this Magazine.

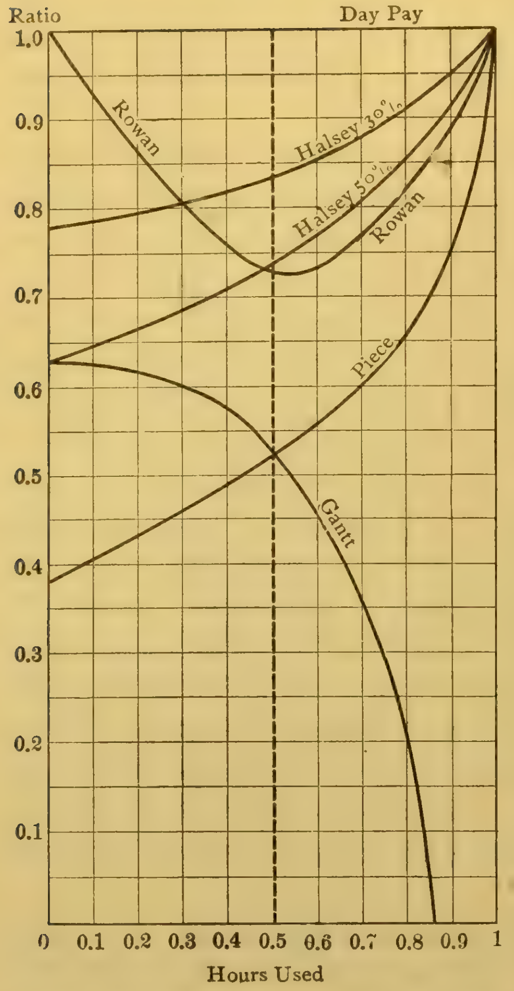

CHART 14. RELATIVE PROFITS, IN PERCENTAGE OF ACTUALLY EMPLOYED CAPITAL, BY TIME SAVINGS UNDER VARIOUS METHODS OF WAGE PAYMENT.

It is not to be expected that time savings beyond one-half will be often realized; for this reason the region beyond is cut off by drawing a heavy dotted line on the chart from 0.5 upward. For time savings up to one-half the curves show that the 30 and then the 50-per cent. premium plans give results approaching in interest for capital that of day pay; then the Rowan plan makes a fair third, and, in fact, at one-half time coincides with the Halsey 50-per cent. The results under piece work fall decidedly short, and those under the Gantt plan still more so, particularly in the region of the smaller and, therefore, more readily attainable time savings; at one-half time the Gantt plan gives the same results as piece work, and better than this for greater savings.*

Readings from the curves showing the values of various plans in interest returns on the capital actually employed at a few time savings are given in the small table as follows:

TIME SAVINGS.

Plans	1	0.75	0.5	0.35
Day	5 per cent.	33 per cent.	97 per cent.	258 per cent.
30 per cent......	5 “	29 “	80 “	208 “
50 per cent......	5 “	25 “	70 “	177 “
Rowan	5 “	23 “	70 “	207 “
Piece	5 “	19 “	50 “	118 “
Gantt	5 “	10 “	50 “	152 “

On Chart 14 the value of the various plans is illustrated by curves giving their ratios with day pay, when the latter is taken as a unit;

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* The bonus for the Gantt curve given is 50 per cent. of the normal day-pay wage; with lesser bonus the interest returns will rise. This method is employed by its originator only in connection with a very thoroughly worked-up system of supervision and instruction, insuring the attainment of large time savings.

thus at a time saving of one-half the interest returns are 1 for day pay, 0.83 for Halsey 30-per cent., 0.73 for Halsey 50-per cent. and Rowan premium, and 0.52 for both piece-work and Gantt bonus plans. This chart also shows quite clearly the point made by the originator of the Rowan system—its value in raising the returns to capital when time savings are increased materially beyond one-half. Mr. Rowan takes the position that such savings are realizable only by the introduction of improvements in plants and methods outside of the workman's control and entirely at the employer's expense, so that in all fairness the latter should again share more largely in the returns. In the character of work done in the Rowan shops—heavy marine engines and boilers with very little repetition work—that is very likely true.

So far it has been my aim to present the subject, divested of all personal opinion, allowing each reader to draw his own inferences from the matter itself.

My own conclusions from the matter presented in this and the previous two chapters are that:—

1.—From the workman's point of view:

A.—Whenever time savings are possible, piece work, when guaranteed against cutting, is preferable, but

B.—Experience with piece work has shown the general great difficulty of keeping it free from rate cutting; taking into consideration also the penalizing effect of a lessening wage rate when time is lost,

C.—The premium systems, such as the Halsey 30 and 50-per cent. and the Rowan, in the order named, best conserve his interests; they have the merits of an increase in earnings for increased effort, without making this so great as to excite the danger of cutting, particularly as these systems are often coupled with a distinct guarantee against that, and also because they insure a minimum wage rate when time is lost.

2.—From the managing employer's point of view:

A.—Day pay would be the most desirable plan, as giving the greatest profit, provided the men could be stimulated to the necessary effort; but the difficulty is so great as, in most cases, to render the adoption of day pay inadvisable if large time savings are looked for.

B.—The piece plan provides the necessary stimulus for increased effort, but gives relatively low profit returns; it is also in general disfavor with workmen's organizations, and in case of error in the direction of too liberal a time allowance practically necessitates objectionable rate cutting; in view of this

C.—The premium plans are a compromise that result in profit returns most nearly approaching those of the day-pay ideal; they are acceptable to the men and their unions, and avoid the necessity of rate change in case of too liberal a time allowance, since only a part of the wage value of the error appears as an element of cost. The 30 per cent. or other low-rate plan is best for skilled labor attending the machines, and a higher rate where greater muscular exertion is called for; for heavy machine work, not often repeated and demanding outlay for plant and tool improvements, the Rowan plan has claims to serious consideration.

3.—The interests of invested capital are also best served by the premium plans for the reasons just enumerated, and further because they result in:—

A.—The highest attainable interest return on the capital invested.

B.—They provide in the most acceptable way that stimulus necessary to bring about time saving which results in the more frequent turn-over of capital, or in its release for further employment in other lines.

4.—In an interest far more general than that of the individual employer or capitalist—that of the entire consuming and producing race of man—those methods of wage payment are best that combine the highest wage and interest returns for both workman and capital, while tying up the least amount of labor effort and capital; since, in that way they increase the producing power of both and make both freer to exert their beneficent influence in the production and distribution of more and more necessaries and luxuries in a never-ending chain.

EDITORIAL COMMENT

TO the transfer of the title to the Panama Canal Company's property, assuring our ownership beyond the shadow of chance of question, the events of the past month have added perhaps the most gratifying assurance of all in the appointment of Mr. John F. Wallace to the post of chief engineer. This assurance is that the work of making the canal will be carried out with the careful study, the sound decision, the full preparation, the energetic action, the executive direction, and the unswerving integrity which alone are adequate to so momentous a National undertaking. Mr. Wallace's record is witness to his unusual administrative capacity—his tact and ability in harmonizing and controlling the many elements necessary to the conduct of great enterprises. He is a sound engineer whose work has been notable in many lines that will meet in this great undertaking. With an exceptional range of experience he combines a sense of proportion and a balance of judgment invaluable in dealing with new problems. Under his initiative and control, we feel content that the work will be carried on upon a sound business basis. To its successful accomplishment we are confident Mr. Wallace not only will devote the uttermost of his own eminent ability, but will bring all other specialized knowledge, talent, or experience capable of contributing to the best execution of the vast project which the United States has undertaken in the interest of the world.

* * *

WITH the opening of the international exposition at St. Louis we may again call attention to a curious and almost inexplicable fact which re-appears continually in such displays. Millions are expended by governments and by individuals for the creation of magnificent buildings, and these are filled with expensive and comprehensive exhibits at further large cost, and then these exhibits are, in very many cases, either neglected or placed in the charge of wholly incompetent or indifferent individuals. It has been the experience of almost every interested critical or scientific visitor at any of the great expositions, from the Philadelphia Centennial down to the present time, that the things which he desires to see and to understand have been found either utterly neglected, or else in the charge of some one who, if he does not treat the visitor with absolute rudeness or discourtesy, is entirely indifferent and unapproachable. Who does not recall the insolent subordinate, tilted back in his chair, his feet up on his desk, with a smouldering cigar stump between his teeth; or, perhaps the surly individual in overalls, unable or unwilling to give attention to the very persons for whom the exhibits have been sent or installed. That there are exceptions to this unsatisfactory rule, we gladly admit, but speaking from an extended personal experience at many great expositions on both sides of the ocean, the writer cannot but affirm that, in the engineering departments especially, the neglect of proper attendance is most general.

There are various reasons for this state of affairs. In many cases the choice of the representative is made from altogether different reasons from those which would command efficiency. It is considered something of a pleasure trip by many firms, and the post is given to some younger member of the family, or to some friend who wants to see the show at the firm's expense, while the really competent man is thought to be needed too much at the works or in the office to be spared for such a holiday. Holiday it should not be, but rather a most difficult and exacting task, demanding the highest degree of tact and experience, together with familiarity with the whole state of the art of which the exhibit forms a part. To send any inferior person is to waste in great measure the benefit to be gained by all the expense which has been incurred in sending the exhibit.

There is now time at St. Louis for a reform to be instituted in this matter, and it will be a subject of interested investigation, upon which we hope to comment later, to determine the extent to which exhibitors have learned by experience. To install an expensive and creditable exhibit, and then to hedge it about with bars and ropes and leave it to itself, or to place it in charge of an indifferent and incompetent person, who feels it his whole duty to acquire the insolence which comes from a brief investiture of power, will be to nullify in great part the value of the display ; while the presence of a courteous and intelligent attendant, who welcomes every caller as a personal friend of his firm, whose inquiries are to be met half-way and whose studies to be encouraged and aided, will render the St. Louis exhibition notable.

* * *

IN our issue for March last we reviewed at length the discussion upon the relation of the administration of the patent laws of the United States to the development of the mechanic arts, which took place at a meeting of the Technical Society of the Pacific Coast, and quoted the remarks of Mr. John Richards, himself one of the best-known engineers in the country, to the effect that the present conduct of the United States Patent Office "is an amazing example of routine work, done by rule, and apparently without personal discretion—by rules that have grown out of the conduct of the office and the circumstances of procedure."

Mr. Richards attributed the present low standard of patent-office work to the fact that the examiners are men of limited attainments, at moderate salaries, and without any especial interest in seeing that their work is judicially done, while opposed to them are large numbers of able, skilled lawyers and patent solicitors, actively engaged in pushing the interests of their clients. These views have attracted much attention, and their correctness seems to be fully confirmed by the fact that Mr. Edison has had to appeal to the President of the United States in order to secure even consideration for his statement that the contents of a recent application of his own were divulged to another applicant, who was allowed to withdraw his application and incorporate in it some of the features of Mr. Edison's invention.

In a subsequent newspaper interview, Mr. Edison is quoted as stating that the trouble lies largely with incompetent examiners. "They take a couple of young men out of the bottle department or the collar-button department and set them to work examining an application for a system of wireless telegraphy or some similar thing."

The young men are not to be blamed, of course, since it is their duty to try and do their best, however ignorant they may be, but what is to be thought of the Commissioner under whose administration such things can occur, or, who, being appealed to, permits the appeal to get past him to the President?

REVIEW OF THE ENGINEERING PRESS.

"THE WORLD IS ITS FIELD"

MARINE STEAM TURBINES.

STEAM TURBINE PROPULSION FOR GENERAL MARINE SERVICE AND HIGH-SPEED TRANSATLANTIC LINERS.

A. Rateau—Institution of Naval Architects.

ALTHOUGH the steam turbine was early applied to marine propulsion on a small scale, its subsequent development, until recently, has been in stationary service, doubtless because of its applicability for direct connection to dynamos operating at high rotative speeds. During the past few years, however, the development of the marine turbine has been rapid, and its successful applications to vessels of large size, both for river and channel service, have demonstrated the fact that it is well adapted for general seagoing vessels.

At the recent meeting of the Institution of Naval Architects a paper was presented by Professor Rateau, of Paris, upon the subject of steam propulsion for marine purposes, and about the same time the announcement was made that the directors of the Cunard Company had decided to adopt turbine propulsion for the new express steamers to be constructed for their line. We give some abstract and review of Professor Rateau's paper, and also some notes from an editorial in *Engineering* upon the action of the Cunard Company.

The paper of Professor Rateau is especially interesting from the fact that it discusses the performance of turbines upon a vessel identical in all other respects to some which have been equipped with reciprocating engines. The boat in question was a torpedo boat, built by Messrs. Yarrow, and was similar in all respects to thirty other boats of the same firm. The boat was also peculiar in being fitted with a small reciprocating engine, for reversing and for cruising at reduced speeds, this engine being connected to the central shaft, and the side shafts being driven by Rateau turbines; there being three shafts in all.

According to Professor Rateau, there are three principal difficulties encountered in the use of steam turbines for marine propulsion. These are the proper design and arrangement of the propellers for high rotative speeds; the low efficiency of the turbine at low speeds; and the provisions for reversing and manœuvring.

The first two difficulties arise from the fact that the best efficiency of the turbine is attained at high speeds, while the best action of the propellers is secured at lower rotative speeds. In some of the earlier turbine boats propellers of very small diameter were used, several being placed on each shaft, and this appears at present to be the most practicable solution of the question. Larger single propellers involve larger turbines, and this brings with it greater weight, thus causing one of the chief advantages of the turbine to be reduced. According to Professor Rateau, there is a lower limit of speed, below which the use of turbines cannot be recommended. This limit he places at about 20 knots, but since turbines are now being applied to transatlantic liners intended to be run at 17 knots, so that practical data of performance will be available upon this question.

Reports of trials made upon the Yarrow torpedo boat show that for a development of 2,000 horse power the steam consumption was 13.4 pounds per effective horsepower-hour, which corresponds to 11.7 pounds per indicated horse power for a reciprocating engine having 12 per cent. loss due to internal friction. This is excellent economy, and when it is understood that the total weight of 2,000 horse power of turbines is only 17,200 pounds, or 8.6 pounds per horse power, the advantages are apparent. The reciprocating engine used for cruising and reversing in this case is of 250 horse power, this having been found ample for the purpose. The turbines may also be arranged for going astern, if required, although this is hardly considered necessary.

While this combination of reciprocating engine and turbines appears to be most practical and useful for naval purposes, where much cruising is done at low speeds, and where full power is required only for a small part of the time, it is hardly necessary for transatlantic liners, which are driven at full speed nearly all the time they are at sea. This was the problem presented to the commission which reported upon it to the Cunard Company, and doubtless the special conditions had an important bearing upon their conclusions. The commission, consisting as it did, of engineers familiar with all sides of the question, have furnished a report of more than passing importance.

"The Cunard Company started with the resolve that the two vessels to be built under the agreement with the Government for carrying the American mails and for service as mercantile cruisers in times of war should represent the highest possible attainment, alike in naval architecture and marine construction; and if the negotiations in connection with the design of the vessels have been more than usually protracted, full justification will be found in the many important innovations, making for reliability and success, likely to be introduced into their construction. In the first place, extensive model experiments were carried out to determine approximately the power necessary to attain the speed anticipated in the agreement with the Government, of from 24½ to 25 knots, with different dimensions and varying lines. It is understood that the result was that a length of 760 ft. was found to meet most of the requirements, but that the weights to be carried demanded a beam in excess of that hitherto found necessary for merchant ships, some of the models ranging up to 88 ft., so as to give a high prismatic coefficient of fineness to minimise the power necessary to give the speed."

Having determined the data for the hulls, the question of motive power was to be considered, and it was upon this point that the special commission reported. Tests were made upon the turbine steamers running between Dover and Calais, and between Newhaven and Dieppe, and also upon turbine engines in stationary service, and every attempt has been made to secure reliable data upon which to base conclusions. Discussing the subject editorially, *Engineering* says:

"The report, it is said, reviews the turbine from every standpoint, and is probably the most carefully-prepared judicial pronouncement on the subject yet made. When the turbine was first proposed, it was naturally anticipated that there would be a saving in weight per unit of power, and this became a most important matter in the case of a vessel that must develop something like 70,000 indicated horse-power to get a speed of 25 knots. But it is now understood that the Commission place the economy in weight at nearer 3 per cent. than the 10 per cent. at one time thought possible. On the question of fuel economy there has always been difficulty in arriving at definite data; but here the trials of the Midland Railway Company's new boats, which differ only in their propelling machinery, will yield valuable information. It has been stated that the trials of the Channel steamers showed an economy of 2 per cent. as compared with reciprocating machinery; but there is an accumulation of reliable data to show that in electric light stations a much greater saving is realised. In such marine installations as have been the subject of comparative trials there were other variants influencing the issue. At low power there is now no question that the turbine is not so economical. But this disadvantage operates more in the case of naval ships, where the greater part of the steaming is at low power; it does not affect the merchant ship—especially the Atlantic liner—which runs for 99 per cent. of her time at full power. The turbine machinery can therefore be easily designed to give the highest efficiency at full power; and good results will thus be insured."

In some respects the points made by Professor Rateau have evidently appealed to the commission, especially that of abandoning the use of several propellers on each shaft.

"It is understood that four shafts will be fitted in the new ships, probably with one propeller and one go-ahead turbine on each. This is not the first installation of quadruple shafts to be carried out. Hitherto in British ships three shafts have been installed; but the first turbine-driven war vessel built for the German navy, the Lubeck, recently launched from the Vulcan Works at Stettin, has four shafts. In this case the decision was doubtless influenced by the question of economy at low power. When two of the shafts are run for low speeds, higher efficiency will be attained, because the two turbines will run faster than if three or four were in use for the same power: it is well known that steam loss increases as the revolving speed decreases. In the Cunard liners, however, the four shafts are almost a necessity, as is would be inadvisable to transmit the enormous power required through three shafts. While a sea speed of 24½ knots may be got with 65,000 horse-power, there must be something in reserve to ensure regularity in the hour of arrival. The adoption of the four shafts has the great advantage of increasing the duplication, so that there will be the minimum of delay consequent upon the fracture of a shaft or any breakdown of one of the four propelling units. There will likely be two distinct steam cycles, the two low-pressure turbines being placed on the two inside shafts, while the high-pressure turbines will be on the outside shafts. The two reversing turbines will also be placed on the inside shafts. The intention, we understand, is to minimise the revolutions of the propellers, as experience has shown that slow-running, large-surfaced, coarse-pitched propellers give the best results."

In view of the eminence of the members of the commission and the great care which they have evidently taken in their work, this report must be considered as one of the most important engineering documents of the time. The execution of the work in accordance with their recommendations will put their opinions to the test, and complete success will mean a revolution in transatlantic express service.

CONTINUOUS INDICATOR DIAGRAMS.

METHODS OF OBTAINING CONTINUOUS RECORDS OF THE ACTION IN ENGINE CYLINDERS BY USE OF THE ORDINARY STEAM INDICATOR.

W. Schüle—Verein Deutscher Ingenieure.

SINCE the original invention of the steam-engine indicator by Watt, nearly all the improvements have been made in the direction of greater accuracy and adaptability to modern conditions of speed and pressure. With but few exceptions the indicator has consisted of two elements: a pencil, shifting its position in accordance with the changes of pressure in the cylinder, and a recording surface moving in synchronism with the piston. Usually these movements occur in a cycle, so that if the instrument is applied continuously a succession of closed diagrams are superposed upon the same card. For many purposes this arrangement serves well, and there is no doubt that the great advances which have been made in steam engine design and performance have been largely due to the practical information gained by the use of the indicator since its improvement by Richards and his successors.

There are, however, a number of operations for which it is very desirable to have the successive cycles separated and arranged consecutively, so that their sequence may be studied as well as their separate characteristics. Thus, in the case of the gas engine, the action of successive strokes may be very different, especially if the hit-and-miss method of governing is employed, and any attempt to compute the power of an internal combustion motor without a comparison of a large number of consecutive diagrams, showing the actual number of power strokes and the accompanying action would be most misleading.

It is also desirable in some instances to have the pressures recorded at uniform time intervals. The motion of an engine piston is necessarily variable, ranging from a maximum to zero twice every revolution. If this speed variation is accurately reproduced upon the indicator drum a correct diagram will be obtained, it is true, but such an arrangement gives the slowest motion at and near the ends of the stroke, crowding the record into a small space at the very point where it is most desirable that it should be open and easily read and studied.

A number of continuous indicators have been designed, one of the first of these being by Gooch, the eminent railway engineer in the early forties, and this instrument, with its stiff, elliptical spring, short stroke, and small moving parts was a noteworthy improvement on its predecessors. For simplicity, however, it was made to use curved pressure ordinates, so that its records were not directly comparable with other existing instruments, and it is now only a mechanical curiosity. Later continuously operating indicators have been designed, some of them very complete and complicated, but their cost and character have rendered them applicable in general only to the testing laboratory or the research bureau.

In a paper recently published in the *Zeitschrift des Vereines Deutscher Ingenieure* Herr W. Schüle describes a plan for obtaining "time" diagrams with a modification of the ordinary indicator, and the plan is also suggestive of a similar arrangement for taking continuous diagrams, when such are desired.

The idea of a diagram in which the pressures should be recorded at uniform time intervals includes the independence of the motion of the paper drum from that of the engine, a condition which is advantageous in many ways. It removes at once all difficulty in securing the accurate synchronism between drum and piston movements which is otherwise necessary; besides which it enables all irregularities in various parts of the action of the engine to be studied upon an absolute time basis. Such diagrams may readily be obtained by removing the drum spring and arranging the drum so that it may be given a continuous and uniform motion of revolution about its axis. This uniform rotary motion is provided in the apparatus of Herr Schüle by an ingenious application of the principle of the well-known Atwood's machine. The indicator, which may be of any one of the well-known modern types, is so placed that the drum is in a horizontal position, the drum spring having been removed and the drum being left free to revolve. A cord, with equal weights attached to the ends, may then be hung over the groove in the drum, and the motion started by placing a small auxiliary weight upon one of the two main weights. As soon as the resistances have been overcome the auxiliary weight is removed by a properly placed catch, and the velocity thus acquired is continued uniformly. At this moment the recording pencil is applied and its movements are traced upon the uniformly revolving drum. Several superposed diagrams are thus obtained, while by a slight modification the drum may be arranged to wind off a continuous strip and thus separate all the records, the successive strokes appearing as a continuous line.

Herr Schüle has made careful investigations and calibrations of the instrument used by him, in order to determine all the resistances which may affect the result, and this portion of his paper should be consulted by those who may attempt similar arrangements, since these resistances are different for every instrument. Careful tests show, however, that practical uniformity is obtainable with this simple apparatus, and its value will be readily apparent.

A number of diagrams taken with this form of indicator are given by Herr Schüle and the insight which they give into the action of the steam and the valve gear, especially near the ends of the stroke, is apparent. The change from compression to lead curves, too often skilfully concealed in the ordinary diagram, is clearly brought out, and the behaviour of the valve gear, even at its most rapid portions of travel, may be seen. By arranging instruments connected with both ends of the cylinder to make their records upon the same drum, the impelling and resisting forces may be studied as they really occur, and a clear idea of their action obtained.

Diagrams traced by the "time" indicator may readily be transformed into those of the usual form by transferring a number of points, and Herr Schüle gives examples of such transformations, as well as a number of studies of diagrams from engines of well-known builders.

Although such continuously recording indicators may doubtless be prepared according to the plan suggested and employed in this valuable paper, it is most desirable that such instruments should be primarily constructed and calibrated especially for the purpose by competent instrument makers, in order that results obtained in various places by different observers may be strictly comparable. The great value of the continuous time diagram, both for the steam and the gas engine, is fully shown in the paper of Herr Schüle, and the method would doubtless come into extended use if standard instruments were readily obtainable at moderate cost. That such instruments can be made at no greater cost than the ordinary indicator is evident, and all that is needed is the undertaking of their commercial manufacture by competent hands.

THE ADAPTABILITY OF ELECTRICAL DRIVING.

A COMPARISON OF MECHANICAL AND ELECTRICAL TRANSMISSION AND SUBDIVISION OF POWER IN THE WORKSHOP.

B. Longbottom—Manchester Association of Engineers.

ALTHOUGH much has been written about the advantages of the electrical driving of machinery there is not an abundance of reliable information concerning the real difference between the old method of shafting and belting and the new one of line wires and motors, so far as actual efficiency is concerned. Much of the published matter is general in its character, and close comparisons are not readily attainable. For this reason the paper of Mr. Longbottom, presented before the Manchester Association of Engineers, and published in the *Electrician* is of value and interest.

In this paper there is an attempt to make a direct comparison between mechanical and electrical transmission, taking into account the practical working conditions. Certain assumptions must necessarily be made, but the principal data have been derived from actual tests, and the deductions appear to have been impartially made.

In the case of ordinary mechanical driving, employing shafting and belting, the principal point to be taken into account is the power required to drive the empty shafting, and its auxiliary attachments, countershafts, etc. Mr. Longbottom gives data of a number of tests to determine this point, choosing his data from plants ranging from 30 to 900 horse power, ranging from one-half to full load. The proportion of the total power absorbed by the transmission necessarily varied, being the greatest for the smaller installations, the power required for the transmission ranging from 25 to 75 per cent. of the whole. Mr. Longbottom, after weighing the conditions in each case, estimates that the average effective power delivered to the machines may safely be taken as 55 per cent. of the total indicated power of the engine.

In the case of electrical transmission the losses may be divided into several parts. Making allowance for the losses in the engine and generating plant, it is estimated that an efficiency of 82 per cent. can be reached at the engine-room switchboard. From thence the losses are divided between the distributing cables and the motors. The distribution losses in an ordinary shop are small, for full load the transmission losses are taken at 3½ per cent., of 2 per cent. at three-quarter load, this bringing the efficiency at the motors, to 80 per cent.

"We can reasonably assume the motor units in our example to be 5 B.H.P., and 10 B.H.P., and take 7½ B.H.P. as the average. Assuming again three-quarter load, which will imply an efficiency, say, of 83 per cent. as the mean efficiency of the motors, we have a total efficiency at the motor-pulleys of 83 per cent. × 80 per cent. = 66½ per cent., or 66½ B.H.P. In the case of the individual machine when driven direct, it is obvious that no further loss takes place, but when the machine is driven by gearing, chain or belt, there is a loss of 2½ to 5 per cent., and this must be deducted from the efficiency at the motor shaft. As far as engineering works are concerned, latter-day practice shows a decided tendency towards this method of driving, as the power required to drive small machine tools has been greatly increased by the advent of high-speed tool steels, and increased cutting speeds. However, in the majority of electrically-driven works, it can reasonably be assumed that from one-quarter to one-third of the power is taken up by group-driving We will take the latter to be the case, so, continuing with our example, we have two-thirds of the available power—say, two-thirds of 66 B.H.P. (44 B.H.P.)—reduced a further 3½ per cent.—*i. e.,* 1.55 B.H.P.

Tests which have been taken at hazard, show that the frictional losses in well arranged group-driving should vary from 10 to 25 per cent.

For the remaining 22 B.H.P. we will then assume a liberal frictional loss of 20 per cent., which amounts to 4.4 B.H.P. This gives a total loss of, say 6 B.H.P., which must be further deducted from the 66 B.H.P. at the motor shaft, leaving us with an efficiency of 60 per cent. for electrical distribution as against 55 per cent., which was taken as the fair average for mechanical distribution."

Comparisons made at lighter loads show somewhat more favorably for the electrical transmission, since the transmission losses are proportionally larger for the mechanical system at partial loads, while this is not the case with electrical driving.

So far as the much discussed question of independent or group driving is concerned, Mr. Longbottom has some interesting remarks.

"In the past there has been a great diversity of opinion as to whether each machine should be driven by a motor, or a number of smaller machines should be grouped together and driven from a short line shaft by one motor, but it is now generally recognised that where machines are in constant use, provided they are below a given horse-power—say 5 H.P.—grouping is the most desirable. This method most successfully overcomes the great variation of power that is experienced in the driving of small machines, due to the difference in the load, and the cycle of operations, and is naturally more efficient than if a number of smaller motors were employed on account of the necessarily lower efficiency, as well as more economical in first cost and upkeep. Moreover than this, the aggregate of the horse-power of the single motors would be much higher than the horse-power of the one motor driving the group of machines, as each of the smaller motors must be large enough to deal with the maximum load of its machine, whereas only a slight addition is required to the average working load in the case of the group motor, sufficient to be capable of dealing with the heaviest loads of a certain percentage of the machines in question."

In order to secure the best results from group driving care must be taken that too many machines are not driven from one motor, or that they are not spread over too great an area, since it is possible in this manner to introduce losses which would exceed those due to the old method of mechanical driving. Judgment should be exercised in the choice of a proper system of motor units, the machines being subdivided into the most efficient groups to suit the units. In the average engineering works the smallest unit may be taken as 5 horse power, while other useful units are 7½, 10, and 15 horse power; larger units are only required for individual driving of heavy machinery.

"In these days of specialisation, it is of the greatest importance that machinery and departments should be arranged with a view to economical and increased output, and it is now possible for the works organiser to achieve this result without taking into account how the power has to be delivered to the machines. It is no longer necessary to arrange the machinery in parallel lines down the works, so that it can be driven from line shafts supported from the main girders, as is the case with the best arranged mechanical distributions; but under the same roof he can have as many sections or departments as he wishes, each entirely self-contained.

"It is quite probable that in attaining this result some sections will not be driven as efficiently as may have been possible, but provided the production is increased by the arrangement with the same outlay in labour, it justifies itself. The saving of power in such an instance is of secondary consideration. Now that there is no longer the weight and strain of heavy shafting on the girders to contend with, lighter structures can be used, resulting in a material reduction in the cost of the building, thus further defraying the cost of the electrical plant.

"Then the advent of portable machine tools and other labour-saving devices has been rendered more possible by the electric motor, and the economies to be obtained by these methods of manufacture are daily becoming more apparent.

"Again, in new works there is always a danger with mechanical distribution of the power plant becoming too small as the business increases, with disastrous results as far as further development is concerned; but an electrical system is perfectly elastic, it being only necessary to put down another generating unit and an additional panel on the main switchboard, and this can be done without in any way affecting the efficiency of the existing plant.

"It is now possible for the smallest user to obtain electricity for power purposes at a price varying from 1d. to 2d. per unit from our corporation and supply companies, and this must be of vital importance to young firms who require their available capital for other useful purposes, especially when they have the knowledge that their power costs them comparatively little more than would have been the case if they had had a plant of their own."

These investigations of Mr. Longbottom only serve to confirm what has been accepted as the result of general practical experience; that is, that the actual saving in the mere transmission of power by the electrical over the mechanical system is hardly great enough in itself to warrant the change. The small saving in power is undoubtedly effected, but the power element in the cost of manufacturing forms such a small portion of the total cost of the finished product that the gain in reducing it by a small percentage is almost immaterial. The great advantages of electric driving are altogether due to other elements than those of transmission. It is in the saving of the valuable room, in the ability to place machines according to their most efficient use, regardless of the location of the engine or shafting, and in the general improvement in operation of the whole plant that the great advantages lie. Even if the transmission losses were greater with electric driving it would be a gain in many cases to make the change, and since it has been shown that there is no loss, the added advantages are a clear advance in the operative element of works management.

RECIPROCATING STEAM ENGINES.

THE HIGH ECONOMICAL PERFORMANCE OF MODERN RECIPROCATING STEAM ENGINES IN COMPARISON WITH THE STEAM TURBINE.

J. A. Seymour—Electrical World and Engineer.

IT has rather become the fashion of late to assume that all the virtues as a prime mover belong to the steam turbine, and that any engine so hopelessly old-fashioned as to be constructed with a piston reciprocating in a cylinder is not to be considered. For this reason the article by Mr. J. A. Seymour, in a recent issue of the *Electrical World and Engineer* is timely and interesting, and the case, as he presents it, shows that the old friend which has done such good work in the past is not altogether out of the running.

It must be admitted that the steam turbine represents the latest and best work of a number of able engineers and investigators, and that its present state of development has followed numerous series of exhaustive experimental studies. Under such circumstances it is only right that any comparisons which are made should be with reciprocating engines of the latest and highest type, and conclusively based upon the performances of older machines laid aside as misleading.

As a practical engine builder Mr. Seymour naturally refers to the performance of engines made by his firm, but the tests upon which his argument is based have been independently made, and undoubtedly represent accurately and impartially the performance of modern high class reciprocating engines of the best makers. These tests are compared with trials of a Westinghouse-

Parsons steam turbine made by Mr. Mattice, whose name is sufficient warrant for their trustworthy character, and the conditions of the two sets of observations were close enough to permit comparable conclusions to be drawn.

In the first place Mr. Seymour very correctly remarks that the performance at light or partial loads should be considered, since proper provision for overload demands cause the average working load to be less than the full rated power.

"Whatever advantages in actual commercial use the steam turbine may ultimately prove to possess, there are no indications at the present time that among these advantages will be a better sustained economy at light loads than with the reciprocating engine. It is true that "the usual" or "average" rate of steam consumption of reciprocating engines at light loads is excessive, as compared with the full-load economy, but the usual or average reciprocating engine is really an uneconomical and out-of-date machine. The ideal reciprocating engine working with non-conducting cylinder walls, without loss from leakage, cylinder condensation or radiation, should expand to back pressure to secure greatest economy. To expand to back pressure in an actual engine would load it much below its most economical point. It follows that since a modern engine of economical type, having a much lower rate of steam consumption at full load, approaches more nearly the ideal engine than the above-mentioned average engine, it should effect proportionately a still greater saving at light loads; that is, it should have a flatter economy curve. In actual practice this is found to be true."

The results of the tests are given in the form of curves, and from these it distinctly appears that the best performance of the turbine is attained at or about full load, the curves showing a continually increasing rise as the loading is reduced. The reciprocating engine, on the contrary, attains its maximum economy at about 0.8 of the full load, while the flatness of the curve on either side of this point shows that the performance varies but slightly between 0.7 to 0.9 of the full load. In the particular instances under consideration the steam consumption per electrical horse power hour at 0.8 of full load was about 12½ pounds for the reciprocating engine and about 14 pounds for the turbine; the turbine steam consumption fell to about 13½ pounds at full load while that of the reciprocating engine rose to about 12¾ pounds. The reciprocating engine was a vertical cross compound, with cylinder ratios of 4 to 1, with steam jackets and interheater, and the steam from the jackets and reheater were charged against the consumption. Both machines were operated with superheated steam, and both discharged into vacuum; the superheating being about 80° F., and the vacuum averaging 27.5 in. for the turbine and 25.6 for the reciprocating engine.

Commenting on the correctness of the view that performance at average light loads should be taken into account, for electric stations, at least, Mr. Seymour says:

"Central station managers will hardly consider it practical to run steam turbines at their most economical loads without a greater overload capacity than it is proposed to give them, where the station load is a fluctuating one. At times of maximum station load it quite often happens that the steam pressure and vacuum fall off and the loss of pressure in the pipes, etc., increases so that the actual maximum output of the unit under these conditions may fall short of the nominal overload capacity under normal conditions to a very serious extent. In the case of a turbine a very high vacuum is necessary in order to maintain either its capacity or its economy. To secure this high vacuum, particularly under heavy overloads and in warm weather, with condensing apparatus of a commercially practicable size, in most locations, will be an extremely difficult problem, a much more difficult problem than is generally understood, but one which will have to be met."

While admitting the full force of Mr. Seymour's argument for the superior efficiency of the reciprocating engine in its best types over the steam turbine, it is really a matter for encouragement that the latter machine has done as well as it has. It is now rapidly approaching the 150th anniversary of the first patent of Watt, during which time the reciprocating engine has been the subject of the concentrated efforts of the ablest engineers over the entire world. The turbine in its practical form is only about 25 years old, and its possibilities have been realized only during the past decade, and in that brief period it has leaped past the reciprocating engine as it was when the competition began, and is admittedly excelled only by the latest improved types.

While the efforts of engineers to improve the performance of both types may well go on, it must be realized that steam economy is but one of the factors in the economy of power generation. It is not economy of steam which is the final criterion, but economy of money, and there are other elements which go to make up the final result. If the turbine enables economies in first cost, in foundations, in space, smoothness of running, and operative elements to be obtained, it may prove the cheaper source of power, even if it does use a little more steam; it is to the final cost of the power that we must look in making the comparison.

THE DIRECT OBSERVATION OF STRESSES.

VISIBILITY OF INTERNAL STRESSES IN TRANSPARENT BODIES BY THE USE OF POLARIZED LIGHT.

Zeitschrift des Oesterr. Ingenieur und Architekten Vereines.

THE study of the effect of external forces in the production of internal fibre stresses in structural work is one of the most important departments of the work of the engineer, and it has received much attention from many able investigators. Various methods have been employed, but the tendency of late has been to supplement the analytical methods of the mathematician by graphical diagrams and similar ocular demonstrations. These may be lacking in precision compared with the more elaborate methods of computation, but the general insight which they give into the various problems involved gives them a distinct advantage. In many instances the degree of precision thus obtained is quite within the limits of knowledge of the strength of the materials employed, and in any case the employment of two distinct methods of investigation furnishes a check upon errors of computation. A further extension of what may be called the ocular method of investigation is found in the examination of beams and other structural forms of glass of transparent material, using polarized light to enable the distribution and relative magnitude of the internal stresses to be seen and even photographed. Such a method is not entirely new, but it has been greatly extended of late, and in a paper presented before the *Oesterreichische Ingenieur und Architekten Verein* by Herr Otto Hönigsberg, and published in the Zeitschrift of the society, a very complete account is given of some recent investigations in which this method is employed.

In the consideration of the strength of structural shapes there are two elements about which it is desirable that correct information should be obtained. These are the lines of maximum stress, or what may be termed the paths which are followed by the forces between the points of application; and the so-called neutral lines or surfaces, where, owing to the reversal of the direction of the action of forces, the material is free from actual stress.

If the positions of these lines and surfaces can be accurately, or even approximately determined, the general distribution of material in the most efficient manner is made possible, and the whole subject cleared up for further research. In determining the position of the lines of force and the neutral axes and surfaces by computation it is necessary to know a number of things about the material under consideration, and any errors in the assumption of elasticity or homogeneity may affect the result in a marked degree. If, however, it is possible to render the position of these important portions visible, the correctness of the theoretical examination may be verified and the reliability of the more precise computations accepted.

Herr Hönigsberg considers the investigations of Culmann, giving examples of the lines of force as constructed by him for a beam secured at one end and loaded on the other, and also for a curved crane boom, and incidentally compares the lines in the latter structure with those visible in the human thigh bone of similar shape, and proceeds to discuss the accepted methods of determining these lines in metallic structures. He then takes up the subject of polarized light, showing how, by the use of Nicol prisms for polarizing and analyzing the light transmitted through transparent substances any internal stress is made visible by the production of dark and light areas. By shifting the points of application and support the changes in the positions of the light and dark areas in the field of the polariscope are seen to indicate the positions of maximum and minimum stress, so that the distribution of the internal forces may be studied visually in a very interesting and instructive manner.

Applying this method to the examination of beams supported in various manners and with different applications of load, some very interesting information as to the location of neutral and stress lines is obtained, these being shown very fully in the photographs with which the paper of Herr Hönigsberg is illustrated. Although a clear idea of the results can be obtained only by an examination of the photographs, some of the general conclusions may be given.

According to theory there should be, in a beam subject to a bending, a neutral surface within which no stress exists. If this is correct there should appear under the polarizer a corresponding portion which remains dark for all positions of the rotated analyzer. This, however, is true only when the bending is unaccompanied by thrust, a condition which can readily be realized in the experiments and in the investigations of Herr Hönigsberg. The truth of the theory is clearly demonstrated. In nearly all practical cases, however, the forces act both to produce bending and thrust, and the examination by the polariscope shows that the position of the neutral surface is not fixed in such cases, but varies under various conditions.

A series of experimental investigations have been made upon two groups of bodies; these including curved shapes of various kinds, and bodies in which Hooke's law of proportionality of strain to stress does not obtain. Among these may be noted the photographs showing the distribution of stresses in rings subjected to external compression, crank shafts, car coupler hooks, and other shapes. The method may also be employed to show the localization of stress in the case of nicked test bars, and in many other interesting problems.

The location of the lines of maximum stress in beams and other shapes may lead to some interesting developments in connection with the development of reinforced concrete construction, since it will indicate clearly the best disposition of the reinforcing material. It is interesting to note that in some of his earliest work Monier placed the metallic reinforcements nearly in the lines of the actual stresses, although it does not appear that he was led to do this by any experimental investigations.

The researches of Herr Hönigsberg give a most valuable indication of lines along which much fuller investigations should be conducted, and the question is one which should commend itself to the directors of mechanical and physical laboratories as leading to important practical results.

ALCOHOL AS A MOTIVE POWER.

IMPORTANCE OF PERMITTING THE UTILIZATION OF ALCOHOL AS A FUEL AND ILLUMINANT BY THE REMOVAL OF ONEROUS TAXATION.

W. R. Ormandy—Automobile Club.

THE agitation for the removal of the present excessive taxation upon alcohol continues both in England and in America, and although no immediate results have as yet appeared there is every reason for continuing the effort to advance this important industrial and technical matter. The article by M. Dupays, in a recent issue of this magazine, has attracted much attention, and we now note a paper presented by Dr. W. R. Ormandy before the Automobile Club, showing very clearly the advantages which would follow the extended use of alcohol, especially as a fuel for motor vehicles.

There are two reasons why alcohol has not been seriously considered as a source of motive power until recently. One of these is the high price, a matter due almost wholly to prohibitory taxation; the other, its comparatively low calorific power, a property which has been misinterpreted to mean a low efficiency. Leaving aside the question of the artificial increase in cost, due to excessive taxation, the matter of the calorific power may first be examined. Recent experience with gas engines has resulted in demonstrating that the efficiency of internal-combustion motors is by no means dependent upon the richness of the fuel. Lean gases, such as the waste gas from blast furnaces, having a calorific value of only 100 to 120 B. T. U. per cubic foot will give as high, or even gines, as can be obtained from the richer illuminating or natural gases. As a matter of fact the real measure is that of the thermal value of the mixture in the cylinder, and this will be found to vary but little in any case, owing to the necessity for admitting more air for the richer gases. Speaking upon this point Dr. Ormandy says:

"If the question be asked why alcohol was so long neglected as a source of power for internal combustion engines when efforts were being made in every direction to find an outlet for the over-production which was taking place, the answer is to be found in a consideration of the relative heats of combustion of this substance compared with those against which it had to compete. It is near enough for our purpose to take the heat of combustion of alcohol at 5500, and of petrol and paraffin at about 10,250. At first sight it would appear hopeless to compare two such substances as a source of power unless the price of the one possessing lower calorific effect was approximately one-half that of the other. If the value of a fuel were indeed measured by its heat of combustion, this would be the case; but fortunately it is not so. We depend rather on the number of calories which can be converted into work. In this respect it is interesting to follow the gradual development of German alcohol gas engine production. The solitary specimen above referred to showed at a brake test such a consumption that the efficiency was approximately 12½ per cent.—that is to say, 12½ per cent. only of the heat units conveyed into the machine were given out again in the form of work. If we compare with this the results of the comparative tests of the alcohol-driven gas engines entered in 1902, in the competition for the prize offered in that year by the German Agricultural Society, we learn what astounding progress entered in this competition no less than three has been made. Out of the ten machines gave efficiencies of from 32.7 to 30.9 per cent. when working on full load. This is an astonishing result, and it places the alcohol motor very high in the list as an economical machine for the conversion of heat into work."

The fact that a high degree of compression produces a high efficiency of operation in engines working on the Beau de Rochas cycle is well known, but when the mixed charge of air and fuel is compressed to a high degree there is danger of pre-ignition, due to the heat generated by the compression. It has been found impracticable to compress rich gaseous mixtures to the most economical point, owing to the low ignition temperature, and hence the use of high compression has been permissible only with the lean charges. In the case of alcohol there are two reasons for the practicability of high compressions. The high specific heat of alcohol vapor, and the fact that the spirit contains about 10 per cent. of water.

"The conversion of alcohol into a state fit for explosion requires other means than in the case of petrol. This is obvious, when we consider that the heat required for the evaporation of alcohol is about two and a-half times as great as that for petrol, and we have further to bear in mind that there is 10 per cent, of water present, requiring five and a-half times the amount of heat to evaporate it compared with an equal weight of petrol. At first sight it would seem that this would be a serious difficulty in the utilisation of alcohol, but if we calculate the actual amount of heat which is necessary to evaporate a certain quantity of alcohol containing 10 per cent. of water, we find that it amounts to only 5½ per cent. of the total heat of combustion of that same amount of alcohol—in calculating the heats of combustions, in all cases it must be understood that the heat which would be given out by the water vapour in the products of combustion condensing from the form of steam is not taken into consideration. This 5½ per cent. of heat necessary to convert the alcohol into vapour can readily be abstracted either from the exhaust gases of the motor or from the water taking away the heat from the cylinder walls."

An important feature in the use of alcohol is that it is much less volatile than petrol, and has a higher ignition temperature, so that it is far less likely to be a source of accidental fires. Its storage need not be subject to the same stringent regulations, and less severe restrictions may be permitted for its carriage. The fact that it maintains a constant boiling point is important, since this permits the carburetter to be adjusted once for all, a matter which is impossible for the heterogeneous material known under the general name of petrol.

To the practical automobilist, after the advantages of alcohol as a fuel have been demonstrated, the next question is that of operative cost.

"From what has gone before we know that petrol and alcohol stand in the ratio of 2:1 as regards their heat of combustion, but that in the case of alcohol 30 per cent. of this heat is obtainable in the form of work, while in the case of petrol only 20 per cent. can be so obtained.

"We require, then, four parts of alcohol or three parts of petrol by weight to yield the same amount of heat in the form of work. Taking petrol at 1s. 3d. per gallon—price quoted the writer in Hamburg for quantities of 30 gallons—and allowing for the different specific gravities, we should have to buy alcohol at 1s. ½d. per gallon to place them on an equal footing as yielders of power.

"The comparison between paraffin oil and alcohol, taking their relative efficiencies at 15 per cent. and 30 per cent., shows us that these two would have to be sold at the same price to give equal economic results. From now up to the end of 1908 motor alcohol containing 10 vol. per cent. of water is to be had in Germany, delivered at the nearest railway station, at 9d. per gallon, in lots of not less than 1500 gallons, and 10d. per gallon in lots of 40 gallons, cask free, but returnable. To buy in quantities such as a pint at retail dealers it costs at the rate of 1s. 3d. per gallon, at which price it is still cheaper than petrol at 1s. 6d.—by no means an unusual price in England.

"The problem of supplying motor fuel at a price which will not only render it cheaper than petrol, but which will enable it to compete with paraffin oil, has been solved in Germany.

"What are the conditions in England? Buying methylated spirit in quantity, we can obtain it at 1s. 11d. per gallon, and when obtained it is not so suitable as a fuel either for motors or lamps as is the cheaper German spirit."

Dr. Ormandy makes such a strong plea for the revision of the question of taxation, based on the results in Germany, that his own words may well be given:

"Time is too limited for me to go at length into the question of German as compared with English law in regard to alcohol, either as to production, distribution, or use. This in itself is more than subject for a lecture, but I may inform you that although the German Government showed forethought for the chemical industries, they had taken little action as regards legislature concerning alcohol for other technical purposes—heat, light, or power—up to the year 1887. At that time commercial alcohol generally cost, retail, at the rate of 3s. 6d. to 4s. per gallon. Since then note the change! There is scarcely a village in the whole land where alcohol of guaranteed strength 90-95 per cent. cannot be obtained retail at 1s. 3d. to 1s. 4½d. per gallon. At this price it can be bought in stoppered bottles just as we are accustomed to buy mineral waters.

"Although I cannot deal at length with those phases of the German law which have called forth such a notable change, I can, by means of a few statistics, make evident the enormous importance and size of the traffic in technical alcohol has attained, and in some ways compare our own position therewith. In the year 1900-1 Germany produced 406 million litres—about 4½ litres = one gallon. Of this 112 million litres were used for technical purposes. In the same year England's consumption of technical alcohol was 13 million litres. Please note that this total quantity of 13 million litres is a little over half the amount used by the German chemical industries, and about two-thirds of the quantity used in the manufacture of vinegar per annum."

Regarded from an economic viewpoint, the subject is of immense importance, involving, as it does, extended agricultural as well as manufacturing interests.

"In conclusion, I say that the case for a reduction in the price of alcohol for technical purposes is well established. Cheap spirit would place the rapidly-growing motor industry on a secure basis, because the production of alcohol can be extended almost without limit; it would give our chemical manufacturers a chance of gaining some share of the enormous trade now in other hands. Its production might be made, by suitable legislation, to encourage agriculture, to take back to the land some of the 900,000 workers who have left it since 1851, and give us back that physique in our young men, the loss of which is so bemoaned by the members of the National Service League and so worrying to the War-office. It might go far to settle that tremendously important problem of "Our food reserve in time of war." The enormous nutritive value of the potato crop —two and a-half to four times as great as that of a similar area under wheat—in an area necessary to produce, say, alcohol equal as an illuminant to one-half of the amount of petroleum imported yearly, would be of incalculable worth if we were ever in such position that immediate food was more important that prospective light. To be of real value a food reserve must be in this country, and if it is already spread over a large area of the country, so much the better. Give us only a portion of the vast sum which national granaries would cost, and we will improve the state of our agricultural industry, give the form labourer a chance to increase his pittance by winter work—alcohol and starch and dextrin making; encourage new industries and establish old ones firmly, and at the same time provide in a durable form our food reserve."

PRACTICAL AUTOMOBILISM.

QUESTIONS OF CONSTRUCTION AND OPERATION OF MOTOR VEHICLES FOR OTHER THAN PLEASURE PURPOSES.

M. C. Krarup—Iron Age.

THE development of the mechanically-propelled vehicle has taken a trend which is to many a disappointing one, and there is little doubt that the real progress which was expected a few years ago has not been realized. Instead of replacing the horse for purposes of industry and transport, involving great and permanent improvements in he practice of road construction and maintenance, the automobile has mainly proved to be a costly pleasure vehicle, built principally for displays of speed and show, and adding but little to the services in which it was most needed.

An excellent discussion of the present status of automobilism from this point of view is given in a paper by Mr. M. C. Krarup in a recent issue of the *Iron Age,* and the importance of the points brought out leads us to give some abstract of the article in this place.

"It was originally thought and intended that automobiles should take the place of horses in solving the world's short haul transportation problems. They have done nothing of the kind as yet. It was also thought that their main advantages would be their economy and reliability. This hope, too, has so far been disappointed. The automobile, as it has been developed, no more takes the place of horses and horse drawn vehicles than bicycling takes the place of walking.

"A craze for speed, when that quality was discovered to be easily within reach and to hold a charm of its own, overtook the automobile movement (at the Bordeaux-Paris race in 1895), and gradually changed all the original intentions of its leaders; as a mere temporary digression from worthier objects, it was thought, but the movement lost its bearings then and there and has never found them since. It is astray in fads and fancies, as everybody knows, and only a breach with some of its ten-year old traditions and "data" can bring it back to safe ground. This everybody does not know; in fact, it is roundly denied by many. The best men in the movement are, however, perfectly well aware that sooner or later there must be ten automobiles that pay for their going in dollars and cents for one that pays in pleasure, but they vaguely hope that the pleasure cars will show the way and furnish the capital for all necessary new departures. To what degree they are justified in this belief should appear from the following, especially from that in this article which relates to mechanics and designs.

"So long as the automobile movement had an uphill fight against prejudice there was reason for dealing gently with its shortcomings and charitably with its misrepresentations, the latter being frequently only the delusions of unscientific builders. Only the rich bought machines, and they did not care how much the sport cost them. In fact, the cost was an attraction, because it promised the exclusiveness which had entirely vanished from the bicycle.

"But the promise that the automobile would speedily be developed into a popular utility—on the strength of which promise indulgence was asked, and granted, for the vagaries of the sport—has been redeemed in only the most stinted measure. The automobile, while highly and expensively developed as an instrument of pleasure, does not rise to the level of a true utility—superior to previous means employed—except in those branches of work only in which sustained speed is a fancied or real requirement and economy a subordinate consideration. For the rounds of physicians and inspectors, for ambulance calls, for newspaper delivery the automobile meets certain demands, but the moment the foot rule of commercial economy is applied in earnest its ability to compete with the horse cannot be conclusively demonstrated, as proved by the relatively small number of merchants who have adopted it for light delivery work. When it is operated above horse speed and horse hours, the expense shoots upward through 100 channels; when not so operated its advantage is doubtful. Speed invariably means repairs, accidents and high tire bills."

It has been maintained that the demand for pleasure vehicles would lead to an effort for improvement which would advance the entire work of automobile construction, and that industrial vehicles would profit by the expenditures of wealthy amateurs who encouraged the improvement of the expensive racing and touring cars. This is an old story and it has been heard many times in connection with the time-worn argument that horse racing should be encouraged in order that the breed of horses might be improved. One plea is about as useless as the other, and the experience with the racing automobile is of about as little value for the development of the commercial vehicle as is the breeding of the race horse for the improvement of the hackney. At the present time the automobile business bears a close resemblance to the former bicycle trade, encouraged by exhibitions, races, changing models, and all the tricks so well known to the public, and these are beginning to be appreciated at their true value.

Mr. Krarup calls attention to some neglected points in construction which should be considered before real improvement can be expected. First among these he places the tires.

"Probably the greatest misfortune to automobilism as the basis for a new industry was the existence of the air inflated rubber and canvas tire when the automobile was still in its infancy. The air tire had given good service under the light loads of the bicycle. Its adaptation to the motor vehicle forced the evolution of the high speed car, which should have come last, nipped investigation of other forms of spring suspension in the bud, reduced the dimensions of wheels, created the dust nuisance, and still presents unsolved problems. A degree of inflation sufficient to protect the rubber and canvas casing against deformation under the traction resistance (and the rapid destruction resulting therefrom) causes light cars to bounce and gives them small advantage of the spring effect. Under heavy cars, on the other hand, impacts against the casings are too severe for their material, whatever the air pressure, especially at high speed, and in default of better means for obviating early destruction the walls of the casing are usually so thickened with numerous layers of canvas that much of the elasticity is lost, especially that localized yielding to small obstacles which constitutes the air tire's main advantage over metal springs. They do protect wheels against lateral jolts, however, but this virtue is of great value only when high speed is a requirement, as lateral jolts amount to very little under other circumstances."

If as much effort had been directed toward the finding of an acceptable elastic support of greater durability as has been given to the construction of pneumatic tires there is little doubt that success would have been attained.

One of the most important features about automobile development is the production of some other fuel than gasoline. There is no reason why ordinary commercial kerosene should not be used, and in a motor of the Diesel type it would undoubtedly prove entirely satisfactory. The experiments which have been made in Europe with alcohol fuel have demonstrated its entire fitness for a fuel for internal-combustion motors, and with the development of the modern process of making a cheap ethyl alcohol from sawdust this part of the problem appears to have been solved. The removal of the internal revenue tax from denaturized alcohol should be demanded by the technical and engineering world in such a manner as to brook no refusal, since it is by such means alone that the motor vehicle can be supplied with a fuel which is open to all to produce, independently of the monopoly which controls the supply of petroleum products.

Improved systems of cooling, or lubrication, of shielding and protecting the machinery are demanded and must be supplied for commercial automobiles, and these will not be obtained until competent engineers are encouraged to devote their efforts to some more practical type of vehicle than the present high-speed pleasure and racing automobile.

BALANCED COMPOUND LOCOMOTIVES.

THE DEVELOPMENT OF THE DE GLEHN FOUR-CYLINDER COMPOUND LOCOMOTIVE IN THE UNITED STATES.

Engineering News.

IN the application of the compound principle to locomotive engines almost every possible variation of cylinder arrangement has been tried. The early engines of Mallet and Von Borries used but two cylinders, the high-pressure cylinder on one side delivering steam to the low-pressure on the other, and a special valve being used to enable both to receive high-pressure steam at starting. The compound engines designed by Webb for the London and Northwestern Railway were built with two high-pressure cylinders outside and one low-pressure cylinder inside, there being no parallel rods, and the cylinders connected to different axles. In the United States the Baldwin Locomotive Works has built many engines from the designs of Mr. Vauclain, these having all the cylinders outside, the high and low-pressure cylinders being connected to one crosshead. Various arrangements of tandem cylinders have also been employed, and nearly every designer has introduced modifications of his own in details of valve gear, connections, etc.

The present tendency of all these types to crystallize into the four-cylinder balanced arrangement, with inside and outside cylinder and separate crank connection is discussed at length in a recent issue of *Engineering News,* from which we make an abstract.

The original idea of compounding in locomotives was steam economy. This in turn gave place to the effort to get increased power from the constructive limits of boiler capacity. At present there is a third element to be considered, the possibility of complete balancing of reciprocating parts and the consequent elimination of the injurious hammer blows developed at high speeds with unbalanced engines.

"The feature of the four-cylinder balanced compound, which distinguishes it from other types of four-cylinder compounds, is that each of the four cylinders has its own cross-head, connecting rod and crank. Two of the cylinders are placed inside and drive a crank axle. In some designs, all the cylinders drive one axle, while in other designs the high-pressure cylinders drive another. With the four cylinders, and with cranks placed at suitable angles, there is a more uniform turning movement. The special advantage, however, lies in the fact that the weights of the reciprocating parts of one pair of cylinders may be made to balance those of the other pair, thus eliminating the necessity of using counterweights in the driving wheels to balance these reciprocating weights. Only the revolving weights remain to be balanced, and this is a comparatively simple matter.

"In the ordinary locomotive, as is well known, the reciprocating weights are partially balanced by the addition of metal counterweights in the wheels, but all the weight thus added is wholly unbalanced so far as its vertical motion is concerned, and produces a so-called "hammer blow" upon the rail. If the reciprocating parts were wholly unbalanced, there would be a fore and aft vibration and "nosing" which would make the locomotive uncomfortable to ride on and unsafe. If the reciprocating parts were fully balanced by counterweights in the driving wheels, this whole weight would produce an additional stress on the rail at every revolution equal to its centrifugal force, and the locomotive would "roll" badly on its springs. In practice the locomotive designer has to steer between these two extremes and make a machine unbalanced both vertically and horizontally.

"With the small locomotives and moderate speeds which were the rule in the early days of railroading, the matter of balancing was comparatively unimportant. With the heavy high speed engines of the present day, having reciprocating parts weighing perhaps over 700 lbs. on each side, the problem of satisfactory counterbalancing is very serious indeed.

The practical development of the four-cylinder balanced compound locomotive is due to M. de Glehn, who, in conjunction with M. du Bousquet, the superintendent of motive power of the Northern Railway of France, designed and built a number of powerful engines on this plan, in 1895 and subsequently, about 1,500 of these locomotives now being in service.

"The essential features of the design are as follows: (1) The high-pressure cylinders drive one axle and the low-pressure cylinders drive another, the coupling rods between these wheels serving mainly to maintain the proper relative positions of the crank pins. (2) For each cylinder there is a valve and valve gear, with the usual reversing shaft, the two shafts being worked together or separately from the screw reversing gear, so that the lead of the two sets of cylinders can be varied at will. (3) The engine can be converted into a four-cylinder simple engine by admitting steam into the low-pressure cylinders, while at the same time a valve opens the high-pressure exhaust to the main exhaust. The advantages claimed are particularly in the division of stresses and the balancing of the reciprocating weigths, leaving only the revolving weights to be balanced by counterweights placed in the driving wheels."

The principal objections which have been urged against the four-cylinder balanced compound engine are the use of the inside cranked axle, and the complication due to multiplication of parts. In reply to these it is maintained that the cranked axle has been in practical use for many years in England and no difficulty has been found in actual service. The improvements in materials and methods of working should render it possible to use such axles with entire safety, especially with compound engines in which the stresses are distributed and hammer-blow shocks eliminated. So far as complication is concerned, there is no objection to it if corresponding advantages are gained, and the experience in France has proved that smoothness of running and freedom from delays has followed the use of the new engines.

In the United States engines of the De Glehn type with some modifications are built by the Baldwin Locomotive Works, and there is every reason to believe that this design will become popular to the elimination of the earlier Vauclain arrangement. A powerful locomotive for the Atchison, Topeka, and Santa Fé Railroad is illustrated in the issue of *Engineering News* referred to, this being a modification of the De Glehn and the Von Borries type by Mr. Vauclain.

"It is certain that as far as European practice is concerned the four-cylinder balanced compound has established its practical efficiency in the test of extensive regular service, both in regard to the number of engines and the length of time they have been in service. In this country it remains to be seen whether it will be best to vary the steam distribution at the expense of an increase in number of parts, or to simplify the construction at the expense of flexibility in the steam distribution to suit varying conditions. There will very soon be some practical experience with the two types, as follows: Vauclain, four cylinders driving one axle, with two valves, two valve-gears; De Glehn, four cylinders driving two axles, with four valves and four valve-gears. As both of these engines are to be operated on the testing plant at St. Louis we may look for interesting results without waiting for records of service on the road."

RESISTANCE OF MATERIALS TO COMPRESSION.

THE INFLUENCE OF LATERAL PRESSURE UPON THE RESISTANCE OF MATERIALS OF CONSTRUCTION TO COMPRESSIVE LOADS.

A. Considère—Académie des Sciences.

WE have already reviewed in these columns the important investigations upon the subject of reinforcing concrete columns by hooping, as conducted by M. Considère, and we now have a further paper by him upon the general subject of resistance to compressive stresses, presented before the French Academy, and published in *Comptes Rendus.*

The subject of resistance to compression is one which will well repay investigation. In the case of tensile stresses it is quite possible to understand how the material may be extended, and how, within the elastic limit, the internal fibre stresses may oppose the external forces. In the case of compression, however, the conditions are not the same. Matter itself is incompressible, and hence external pressure can act only by reducing the voids which may exist in the material, or by causing an increase in some other dimension than that along which the pressure is exerted. Many substances which are commonly regarded as being extremely compressible, are really only readily deformed, and if confined in all directions they would be found highly resistent. An excellent example of this is seen in a form of boiler-tube expander, in which a cylinder of india-rubber is compressed longitudinally by screwing up a central axial bolt. When such a cylinder is inserted into a boiler tube and subjected to longitudinal compression, it increases in diameter, retaining practically the same volume as before, the tube being expanded radially with great force, the rubber being as incompressible as water.

It is this phase of the question which is considered by M. Considère. As he tersely puts it: Solid bodies cannot be compressed longitudinally without the production of transverse swelling. The compression may therefore be resisted by opposing the swelling. In practice the swelling may be prevented by hooping the body under compression. As already stated, M. Considère has demonstrated the truth of this principle by showing experimentally the great increase which may be given to pillars of concrete by wrapping them with a reinforcement of wire. The practical applications of the principle are apparent, and the method has already been accepted as an important contribution to the art of reinforced-concrete construction. With the assistance of MM. Mesnager and Mercier, M. Considère has undertaken further researches into the influence of external pressure as an element in resistance to compression stresses.

In these experiments the external pressure was applied by hydraulic methods, using impermeable prisms immersed in water under pressure. The prisms were made of mortar, containing from 300 to 600 kilogrammes of cement per cubic metre of sand, and were permitted to set for periods of 10 to 126 days. Their form was that of a short pillar, 30 millimetres in diameter, and 80 millimetres long, this length being thought sufficient to avoid errors due to the variable friction between the ends of the pillars and the compressing discs.

In order that the external hydraulic pressure may act in a manner similar to a metallic hooping, it is necessary that the water should not penetrate into the interior of the mortar. This result was secured by coating the rough surface of the concrete with a layer of pure cement, and then applying to this, with the aid of heat, a coating of wax of 1.5 to 2 millimetres in thickness. The piece under test was placed in a vessel containing water, the plunger of the testing machine head entering the vessel through a cupped leather packing. By this arrangement it was possible to submit the exterior of the concrete pillar to any desired pressure, after which the longitudinal pressure could be applied by the testing machine until failure of the specimen took place. In a few of the experiments a sudden drop in the hydraulic pressure showed that the water had penetrated into the interior of the concrete, and in such instances the results were rejected. From sixty-five satisfactory tests M. Considère tabulates results and plots curves from which he draws interesting conclusions.

The increase in resistance to compression, produced by the opposition of the hydraulic pressure to the swelling, is very marked. Thus a concrete having a crushing resistance of 74.3 kilogrammes per square centimetre under ordinary conditions, was able to resist 227 kilogrammes when surrounded with water at a pressure of 20 kilogrammes per square centimetre, and when the external pressure was raised to 100 kilogrammes the crushing resistance increased to 523 kilogrammes. Similar results were obtained with other experiments and in general M. Considère has framed the following law from the 65 successful experiments: The resistance to crushing of a prism of motor having an ordinary resistance C, is increased to a value A C + 4.8P when subjected to an external pressure P. The coefficient A is equal to unity when the external pressure P is zero, but it increases with the pressure until it reaches a value 1.5 for pressures of 40 to 50 kilogrammes, beyond which pressures it remains constant.

This result confirms in general the experiments made upon wire wrapped pillars, and proves the correctness of the views which have been enunciated concerning that form of reinforcement. In this respect the present experiments are especially valuable, since the method of wire wrapping, although most convenient in practice, hardly lends itself to critical testing methods with the precision attainable by the hydraulic method of reinforcement. These tests go to show what has already been discussed but is not always appreciated; that failure in all cases is due to the forcing of the molecules of the material apart. When the stress is a tensile one the molecules are drawn directly apart; when it is a compression the material is forced apart at an angle to the thrust, the mass of the material acting as a transmitter of the force in a manner similar to a wedge. If a log is being split by a wedge and a hoop of iron is put around the body of the log the end pressure exerted upon the wedge is transmitted as tension upon the hoop. In like manner the compression pressure upon a reinforced concrete pillar may be opposed by circumferential windings, and there is no doubt that this is the strongest manner in which a reinforcement can be applied to structural elements under thrust.

The true principles of reinforcement are those which include the placing of the metallic members in the lines of maximum stress, and M. Considère has done this most effectively in his work.

THE TRANSMISSION OF SUPERHEATED STEAM.

ARRANGEMENTS OF PIPING, INSULATION, AND GENERAL DETAILS FOR MINIMISING HEAT LOSSES IN CONVEYING SUPERHEATED STEAM.

Dr. O. Berner—Verein Deutscher Ingenieure.

IT has long been appreciated that one of the important elements in good steam engineering is the prevention of heat losses in transmitting the steam from the boiler to the engine, and numerous tests have been made as to the merits of different kinds of pipe coverings, as well as upon other appliances. With the later developments in the use of superheated steam it has been found that the heat losses in transmission become especially important and that data obtained from researches with saturated or slightly superheated steam are not altogether applicable to high degrees of superheating. A series of important investigations upon the subject of the conveyance of superheated steam have recently been made in Germany by Dr. Otto Berner, and from articles by him in recent issues of the *Zeitschrift des Vereines Deutscher Ingenieure* we make some abstracts referring the interested reader to the original papers for the full tables and data of the researches.

When saturated steam is conveyed through long lines of pipe the losses may be determined by observing the drop in pressure, but in the case of superheated steam this is not necessarily the case. The true method of observation in the latter instance is the determination of the drop in temperature. Since the advantages derived from the use of superheated steam in engines depends upon its temperature such determinations are especially desirable in this connection.

Dr. Berner examines the two kinds of heat losses, those by conduction and those by radiation, and deduces a general formula, based on the researches of Péclet, to serve as a guide in the conduct of experimental investigations. To these formulas he applies the results of various investigators, including those of Joule, Pasquay, Dulong and Petit, Stott, and Bolam and Grieve. The researches of Stott, made to determine the transmission of heat through the walls of pipes, avoided the use of steam altogether, the pipe being heated within by an electric current, and the external temperature being determined by the alteration in resistance of an encircling wire, and the result showed that the heat transmission was almost directly proportional to the difference in temperature between the pipe and the external air. Tests of various pipe coverings showed a saving of heat ranging between 78 and 89 per cent. The experiments of Bolam and Grieve give similar results, and further indicate that with high temperatures to be dealt with in superheating the external temperature of the covering should be measured, since it is an indication of the cause of loss. The accurate determination of the temperature of the outside of the pipe covering is not a simple matter, and it is impracticable to use an ordinary thermometer for the purpose; the only reliable method is the electrical determination by the use of thermo-electric elements.

Dr. Berner calls attention to the fact that the actual conductivity of protective coverings for pipes at the present time is determined almost altogether by means of measurement of heat losses in pipes. It is, however, most desirable that the absolute conductivity of the various substances be measured in the physical laboratory, independently of the purposes for which they may be used, and there appears to be no difficulty in making such determinations.

Some general investigations upon this subject have been made by Pasquay upon the elements of which such coverings are usually composed. The latest investigations show that silk and felt form the best protective materials, these, when used in sufficient thickness reducing the heat loss by 80 to 85 per cent. of that of the uncovered pipe. At the high temperatures involved in the use of superheated steam, however, the use of organic substances is inadmissible owing to the fact that they gradually lose their moisture and become charred. This difficulty may be overcome, however, by applying a thin protective covering of some plastic mineral substance to the pipe, using sufficient thickness to protect the hair felt or other organic substance from the direct action of the heated pipe. The poor conductivity of air has rendered it suitable for a pipe covering, the principal point to be observed being the prevention of any movement of the air, since circulation would permit the abstraction of the heat by convection. Experiments by Russner with a layer of air 1 centimetre in thickness show a reduction in heat loss of 75 to 85 per cent. over that of the uncovered pipe. There is little doubt that the efficiency of most of the mineral coverings depends upon the imprisoned air in the pores and interstices of the mass, and in many cases such coverings are doubtless simple means for applying an air jacket.

In making tests of heat losses in the transmission of superheated steam through pipes Dr. Berner gives as the quantities to be subjected to precise measurement: the weight of steam delivered through the pipe per hour; the hourly weight of water of condensation; the steam pressure at the beginning and end of the pipe length and the temperatures of the steam at each end of the pipe. From these data may be computed other important relations, such as the velocity of the steam through the pipe, the hourly loss of heat in thermal units per unit of pipe surface, and in general the loss of energy involved in the transmission. Following the general examination of these elements, he gives in tabular form the data and results of his own investigations, these showing that the transmission of superheated steam through pipe systems originally designed for saturated steam results in losses fully twice as great in the former than in the latter case.

The only remedy at present for this increased transmission loss appears to be greater care in the choice and use of insulating materials, together with a reduction in the length of steam pipe connections to the minimum. Dr. Berner calls attention, however, to the effect which transmission losses may have upon tests of comparative performances of engines with saturated and superheated steam. In many cases the increased transmission losses may go far to reduce the gain in the engine, so that the tests should either be made to exclude the transmission altogether, or the efficiency of the transmission of steam from the boiler should be measured separately in each case, so that the true condition of affairs may be understood. There is little doubt that this matter of transmission losses has not been given the same attention as other elements in the use of superheated steam, engineers having devoted themselves with for more activity to the questions of the generation of steam of high temperatures and to engines in which it is to be used than to the conveying it from one point to the other, although this latter operation may have a great influence upon the real gain to be secured.

MILITARY AUTOMOBILES.

MOTOR CYCLES FOR MILITARY PURPOSES—DETAILS OF CONSTRUCTION AND POSSIBLE FIELDS OF USEFULNESS.

Journal of the Royal United Service Institution.

WITH the continual application of machinery and mechanical methods to warfare it was naturally to be expected that motor vehicles would be considered as available for service. Already the subject has been actively discussed, and various papers and reports of trials have been reviewed in these pages. An interesting contribution to the subject is found in a recent paper by Lieutenant H. G. de Watteville, in the *Journal of the Royal United Service Institution,* discussing especially the availability of the motor cycle for military purposes.

In considering the use of motor vehicles in warfare a clear distinction should be made between the different kinds of machines. Motor cars have been seriouslv considered for some time on the Continent, while in South Africa the traction engine has been employed.

"The car and the cycle should not be classed together as one type of vehicle; but they rather form two very distinct groups of one class. The petrol motor is the only link between the two. The motor cyclist and the motor car driver should be kept distinct; just as the cavalry private is not to be confounded with an Army Service Corps driver. This does not mean the exclusion of the car from the combatant ranks; far from it, for there would seem to be a great opening for the rapid conveyance of troops by its aid. But the motor cycle, in spite of its mechanical nature, must not be considered to work with success and efficiency only when used by the Royal Engineers, or by a purely technical corps. It is in this particular that the cycle and car differ fundamentally; the motor driver on the cycle remains first and foremost a soldier, on the car he is a mechanician doing military work. The striking feature of the motor cycle of to-day is its extraordinary simplicity. Notwithstanding an appearance of complexity, it is wonderfully easy for a man of average intelligence to learn the tricks of the engine, and to become an expert motor cyclist in a very short period. In a given space of time it would be easier to train an efficient motor section than a similar mounted infantry unit out of the same material. The motor car driver, on the other hand, requires a far longer training; and when actually at work, cannot give his mind to anything beyond his engines, while the motor cyclist is able to watch the country, and can get off in an instant, thus becoming a dismounted combatant at a moment's notice. The motor cycle can go wherever the car can go; it can, moreover, instantly turn in a narrow road or on a road occupied by troops; it can go along a footpath, across grass, through narrow gates; it can even be lifted over certain obstacles by two men: all these, or at any rate most of these difficulties are unsurmountable for the car. The cycle burns far less petrol—its daily supply will only take an average car some twenty or thirty miles. The cycle can quickly be concealed behind bushes and hedges. The car is far more conspicuous; it frequently raises a trail of dust which obscures the view, and hangs in the air for an appreciable time after its passage. The cycle has little more to fear from side-slip than many species of cars. Its repairs and spare parts are few and extremely simple. In even moderately skilled hands the motor cycle of to-day has been amply proved to be a reliable machine."

The use of the motor cycle in military operations is necessarily diversified. Probably the most immediate use of the machine is in connection with isolated services, such as orderly duties, carrying messages, and aiding in prompt communication. With this comes scouting work, for which the motor cycle appears to be especially adapted. Speed and fairly long radius of action are desirable for this work. With a good machine a man alone may do excellent work. He can leave his machine, use his field glasses, and be on the move again in a few seconds at full speed, while if necessary the machine may be hidden while a reconnoissance is made on foot. The principal objection to the motor cycle for this work is found in the fact that the machine is closely limited to the road. The noise of the motor is also objectionable, and for military machines every effort should be made to reduce it to a minimum.

The use of sections of motor cyclists in action is a more debatable matter, although it presents possibilities. The principal difficulty appears to be that of effecting concerted action, although small bodies of men, not exceeding 30 in number, might be found manageable. This is a question, however, which might well be solved by practical experience in manœuvres and drill, and the value of the information would well be worth its cost.

There are a number of miscellaneous uses for the motor cycle which may probably be the first for which it will be generally employed. Thus the combination of motor men with a signalling corps may well replace mounted signallers, who have already shown their usefulness. This work may be extended to include the use of the heliograph, and this field offers increasing possibilities. Motor vehicles may also be used in connection with engineering work in the field, and numerous special applications will occur to the thoughtful officer.

"The requirements of the military motor cycle are all such that tend towards reliability and simplicity. Excessive speed is not wanted; 25 miles per hour should be the maximum aimed at, rather than 40. Solidity of detail is to be preferred to attractive and less robust models. Air-cooled engines should be retained; water-cooling adds weight, complication, and is far more vulnerable. Weight must be avoided, though not beyond the limits imposed by common sense. Pedals must be fitted to all military machines, though footrests are a comfortable change, and should be added. Even at very high speeds the pedals will be found to remain stationary when the feet are removed—at any rate, on the majority of cycles. A petrol and oil capacity for 150 miles, running over give-and-take roads, should be the minimum. A free engine, that is, a device whereby the cycle can be pedalled or allowed to run free down hill without the engine being in motion should be extremely useful. It would allow a broken-down machine to be pedalled immediately, or also a sound machine, where absolute silence is required; it renders pushing a motor bicycle an easy matter. These points cannot be ignored in military work. Similarly, a two-speed gear —if the new attempts in this direction should lead to success—would be highly desirable. It would enable a lighter machine altogether to do good work over hilly country; the two-horse motor would be found equal to the elephantine three-horse bicycle that has been in vogue during the late season. As it is, two or two-and-a-quarter horse-power should suffice for all military bicycles, provided that the equipment of the man is kept light, that the man himself weighs not more than eleven stone, that the bicycle is not geared high, and that no trailer work is contemplated. A two or three-speed would make the two-horse motor an ideal bicycle engine; but the gear must be thoroughly sound. No hill should then prove too much, even to a heavy rider with a full kit with him. On the vexed question of belt or chain transmission, it is difficult to give a confident opinion. The chain is certainly stronger on hills, and works well in wet weather. When in good condition, the belt is almost as good and far simpler; belt repairs, though vexatious, are effective, and quickly done. A defective chain clutch, on the contrary, entails skilled assistance. The wear on the engine and driving tyre is perhaps the chief drawbacks to the chain. The former can be minimised partly by good construction and partly by skilled driving, the latter necessitates a tyre of either stronger fabric or covered by a special band. The balance is perhaps in favour of the chain. The tyres are, indeed, a great weakness of the motor cycle, but this should be obviated by improvements; perhaps the Wilkinson tread or the Samson Hutchinson bands are the best puncture preventers known; they are also said to minimise side slip. Tyres for military use should be of at least 2¼-inch section.

"The question of noise is mainly a matter of manufacture; and there is not the least doubt that this can be reduced to a very slight audible beat. There is a vast difference in this respect between the productions of various firms. Ease of starting is of paramount importance; this can be greatly assisted by a free engine and chain drive, also by an efficient valve for injecting paraffin into the cylinder when starting work. One detail must not be overlooked—that is, a good prop to support the machine when dismounted, though to the uninitiated this may seem unnecessary. But a motor bicycle, being so much heavier than the ordinary cycle, such a contrivance is for rapid work an absolute necessity. It should take the form of a swinging rod fastened below the saddle to the frame, and held back by a clip when not in use."

Like everything else, the military motor cycle must be an evolution from the existing appliance in accordance with the special conditions of the service, but the time for the evolution is before the demand comes for actual service, and before the skilful use of the machine by the enemy shall have made the experience unnecessarily expensive.

THE EQUIPMENT OF MINING LABORATORIES.

PRACTICAL SUGGESTIONS UPON THE USE OF THE LABORATORY IN SCHOOLS OF MINING AND METALLURGY.

H. S. Munroe—Engineering and Mining Journal.

WHEN the term laboratory was used many years ago it was always supposed to refer to the chemical laboratory, but the scope of the word has become so extended of late that it has become necessary to explain the department of work to which the term is applied. In nearly all educational institutions there are several laboratories, and indeed the chemical laboratory is often overshadowed by the larger and more pretentious mechanical and physical departments.

The employment of laboratory teaching for the departments of mining and metallurgy involves really a combination of mechanical and chemical methods and appliances, and the subject of the equipment and use of such a laboratory forms the subject of a paper in a recent issue of the *Engineering and Mining Journal* by Professor H. S. Munroe, of Columbia University.

Professor Munroe summarizes the objects of the mining laboratory under three heads: the experimental demonstration of fundamental principles and laws; the training of the student in the methods of scientific testing and examination; and the conduct of original investigation and research.

"Under the first head, the object of laboratory teaching is to supplement the class-room work and add to its efficiency. Under the second head, the object sought is chiefly the training of hand and eye in laboratory manipulation, while under the third head the purpose is to add to the sum of scientific and professional knowledge.

"One important question to be decided is the scale of operation—shall the work be done on a small scale with laboratory apparatus, as in chemical and assay laboratories? Or shall we introduce full-sized machinery and attempt to reproduce actual working conditions in laboratory work? Or shall we adopt some compromise scale for our apparatus and methods?

"The study of physical and chemical phenomena usually can be conducted as well on a small scale as on a large one, provided our instruments and methods are sufficiently delicate and refined.

"The testing of engineering materials and the determination of the chemical constitution and physical properties of minerals and ores can be done as well on a small scale as on a large, if only we can secure small samples for our tests that will fairly represent the larger amounts to be treated.

"The testing of machines and processes can sometimes be done on a small scale, but the results of such small scale tests are often of doubtful value, and generally need to be confirmed by tests on a large scale.

"Work on a laboratory scale requires less room, less expensive apparatus, and takes less time and much less work than large scale operations. Small scale work is thus much to be preferred when results of equal value can be secured thereby. On the other hand, large machines and full scale working tests are sometimes indispensable, and in such case must be provided at any cost."

Professor Munroe is undoubtedly in favor of a laboratory provided with large machines, in order that the student may become familiar with the actual operations which he may subsequently be called upon to conduct. In this way much time is saved which would otherwise be expended in visits to shops and works, while the conditions for work and investigation may be made much more favorable than would be possible under actual working surroundings. There is no difficulty in adding to the full sized plant the necessary small scale laboratory, and the true plan is undoubtedly found in a combination of both systems.

The equipment of the mining and metallurgical laboratory at Columiba University is described at length, showing how the combination of a carefully arranged laboratory fitted for accurate work on the small scale is extended by the provision of an installation of crushing, sampling, and concentrating machinery of full working size. Full sized classifiers, settlers, automatic feeders, and centrifugal pumps for supplying these machines with water and ore are provided, and the whole plant is arranged to be run continuously when desired, without requiring large amounts of water or ore, the same material and the same water being used again and again.

"With each of these machines the student makes a series of experiments designed to bring out the physical laws governing successful working, to afford instruction in practical details of operating the machines, and to give opportunity for engineering tests of capacity and efficiency under different conditions of treatment.

"These include the adjustment and regulation of the ore supply, of the feed and wash water, of speed, stroke, and other working conditions to the treatment of different ores and different grades of sand and pulp. In this work the student is taught to recognize the symptoms of irregular working, to diagnose the trouble with the aid of laboratory tests, and to apply the proper remedies. He makes, incidentally, numerous tests of capacity and efficiency, taking frequent samples of ore-feed, and of the different products for quantitative examination, and weighs and measures the ore and water supply and products obtained."

The advantages of this system over that of occasional visits to various works will be apparent, and the only point which appears to be necessary is the active effort of the professor and the instructors to keep the plant up to date, both in equipment and operation. When such a laboratory is allowed to get into a monotonous routine it may fail to fulfil its purpose, but when, as is the case at Columbia, the work is conducted with active and definite purpose, it cannot fail to become a valuable auxiliary.

"The installation of working machines in the engineering school has, incidentally, other advantages. For example, they not only illustrate the lectures on engineering subjects, but in addition serve in the place of much descriptive matter, details of construction, adjustment and operation, with the advantage that the students' conceptions are clearer, false impressions are avoided, and the instructor has more time to devote to critical discussion. Finally, a proper equipment of engineering laboratories should be such as to enable the staff and advanced students to undertake important original investigations of ore dressing questions, many of which await solution. A beginning has been made, at Columbia and elsewhere, in this direction, and it is hoped that much valuable work of this character may be accomplished in the near future. In many cases the machines in these laboratories have been especially designed to facilitate such researches."

ELECTROLYTIC IRON.

THE COMMERCIAL PRODUCTION OF CHEMICALLY PURE IRON BY ELECTROLYTIC PROCESSES AND ITS APPLICATIONS IN THE ARTS.

American Electrochemical Society.

THERE have been numerous attempts to employ the electrical current in the smelting of iron and steel, and some of these have shown sufficient merit to demand interested attention. Another application of electricity in a similar direction is the production of chemically pure iron by the method of electrolytic deposition, and this forms the subject of an interesting paper presented before the American Electrochemical Society by Messrs. C. F. Burgess and Carl Hambuechen.

The deposition of iron by the electric current has been effected many times as a laboratory operation, but recent experiments in the laboratory of applied electrochemistry of the University of Wisconsin show that electrolytic iron can be produced in such quantities and at such a cost as to make it a material of commercial importance.

Until recently the only practical applications which have been made of the process of electroplating with iron have been in the so-called steel facing of dies and electrotypes. The coating thus deposited is not really steel, but consists of pure iron containing occluded hydrogen, the presence of the hydrogen being supposed to cause the hardness which renders it useful for these purposes. The manner in which the hydrogen is held is not definitely understood, but it may be present in quantities equal to several hundred times the volume of the metal, and it may be almost entirely removed by the application of heat.

The authors whose paper is referred to have undertaken a more extended research, and for more than two years they have carried on a series of investigations upon the production of pure iron in quantity by the electrolytic process. Experiments with a variety of iron salts at different current densities, temperatures, and working conditions have been made and the following method adopted as the most satisfactory:

"The electrolyte consists of ferrous ammonium sulphates; the current density at the cathode is six to ten amperes per square foot of cathode surface, and at the anode slightly less; the electromotive force for each cell is slightly under one volt; the temperature of electrolyte is about 30° C.; the anodes consist of ordinary grades of wrought iron and steel; the starting sheets for the cathodes are of thin sheet iron previously cleaned of rust and steel."

The cost of the process appears to have been determined at about one-half cent per pound of iron, not including fixed charges on the plant, it being thus not greatly in excess of the cost of refining copper, and chemical analysis shows the product to have a purity in excess of 99.9 per cent. The presence of the occluded hydrogen, as has already been said, makes the metal almost as hard as steel, and so brittle that it can readily be shattered with a hammer. After the hydrogen has been removed by heating the metal becomes softer, assuming properties of malleability and toughness similar to those of Swedish iron.

It is possible that the pure iron thus obtained may be found useful for electrical purposes. Experiments have shown that the hysteresis, permeability, and electrolytic resistance are greatly affected by the amount of hydrogen present, but quantitative investigations upon these points are as yet incomplete. It would be interesting to have metallographic studies made of various examples of electrolytic iron, since some useful comparisons with iron alloys might be made.

It having been shown that it is possible for electrolytic iron to be produced at small cost, the question naturally arises as to what uses there may be for it. The first suggestion which naturally presents itself is that on account of its purity it would serve as a basis for investigating the properties of iron and its alloys.

Starting with pure iron, alloys of a predetermined and definite composition can be produced, thus making such investigations of greater simplicity. At the moderate cost above given it may be used for manufacturing chemically pure compounds, and for standardizing laboratory solutions.

THE ENGINEERING INDEX

"THE KEYSTONE IN THE ARCH OF APPLIED SCIENCE."

The following pages form a DESCRIPTIVE index to the important articles of permanent value published currently in about two hundred of the leading engineering journals of the world—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every article.

(1) The full title,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published.

We supply the articles themselves, if desired.

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer and works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of any article referred to in the Index, together with all illustrations, can usually be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the journals indexed are given.

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CIVIL ENGINEERING

BRIDGES.

Arch.

A Statical Investigation of Arches of Constant Dimensions (Statische Untersuchung von Gewölben nach dem Verfahren mit Konstanten Bogengrossen). Dr. Robert Schönhöfer. An analytical and graphical study of the statics of the masonry arch, according to the elastic theory of Müller-Breslau. 2500 w. 1 plate. Oesterr Wochenschr f d Oeffent Baudienst—April 2, 1904. No. 62248 D.

Calculation of the Stresses and Design of Railway Structures of Steel Concrete. Walter W. Colpitts. The discussion has particular reference to the parabolic arch, although in a general way it indicates the manner in which stresses may be investigated in arches of other curves. Ills. 2800 w. Ry Age—April 1, 1904. Serial. 1st part. No. 61871.

Cantilever.

A Cantilever Plate-Girder Highway Bridge. Illustrated description of a bridge in Kansas City, Missouri, which crosses two tracks of railway. 900 w. Eng Rec—April 9, 1904. No. 62024.

Erection.

Erecting Bridge Spans by Sliding Them Forward from the Shore. Illustrations of a bridge in Queensland erected in this way with accounts of other erections, especially a parallel case from Finland. 1000 w. Eng. News—April 21, 1904. No. 62175.

Ferry Bridge.

The Proposed Ferry Bridge at Bordeaux. Brief illustrated description of a bridge of the transporter type. 700 w. Eng Rec—April 9, 1904. No. 62021.

Highway Bridges.

Highway Bridges in the Croton Valley. Illustrates and describes the bridges made necessary by the new Croton dam water supply for Greater New York. 4000 w. Eng Rec—April 23, 1904. No. 62376.

Inspection.

The Value of Inspection of Metal Bridges During Construction and Erection. Walter L. Golden. Explains the various stages of inspection work in mill, shop and field, and gives information showing its value. 8500 w. Jour Assn of Engng Socs—March, 1904. No. 62313 C.

Plate-Girder.

A Long-Span Double-Track Plate-Girder Bridge. Illustrated description of a bridge of the Chicago Terminal Transfer Company and the method of transporting. 800 w. Eng Rec—April 16, 1904. No. 62132.

Regulations.

New Official Regulations for Railway Bridges in the Prussian State. Considers some of the more prominent points in the new official regulations. 1500 w. Engr, Lond—March 25, 1904. No. 61938 A.

Rolling-Lift.

Construction of a Scherzer Double-Roller Lift Bridge at Middle Seneca Street, Cleveland Ohio. William J. Carter. An illustrated account of the difficulties encountered in building the bridge, principally the substructure. 2500 w. Jour Assn of Engng Socs—March, 1904. No. 62311 C.

The Construction of the Scherzer Lift Bridge at Newark Bay. Describes the rolling-lift bridge being built by the Central Railroad of New Jersey to replace a steel truss center-piece swing span. 2700 w. Eng Rec—April 2, 1904. No. 61809.

Suspension.

The Elizabeth Bridge, Budapest. Begins an illustrated description of a suspension bridge presenting various novel engineering features, giving also historical sketch. 1800 w. Engr, Lond—April 15, 1904. Serial. 1st part. No. 62341 A.

Trestle.

The Reconstruction of a Timber Trestle. B. B. Boyd. Illustrated description of this work as carried out on the Southern Pacific Railroad in California. 800 w. Cal Jour of Tech—April, 1904. No. 61975 C.

Viaducts.

Experience in the Erection of American Viaducts on the Uganda Railway. A. B. Lueder. The writer was in charge of the work of erection, and gives an interesting report of his experiences. 3700 w. Eng News—April 14, 1904. No. 62046.

The Eggenburg Viaduct on the Vienna-Eger Railway (Der Eggenburger Viadukt im Zuge des Zweiten Gleises der Eisenbahnlime Wien-Eger). Karl Stöckl. Illustrations and details of continuous girder viaduct constructed for the second track of the Vienna-Eger railway; with data and results of tests. 5000 w. 2 plates. Oesterr Wochenschr f d Oeffent Baudienst —April 9, 1904. No. 62249 D.

CONSTRUCTION.

Buildings.

Structural Engineering in Apartment-House Construction. Editorial discussion of phases of construction in current practice in New York, with illustration of a typical building. 2500 w. Eng News—April 14, 1904. No. 62048.

The Extension of the Imperial Hotel, New York. Illustrated detailed description of important features of the work. 3300 w. Eng Rec—April 16, 1904. Serial. 1st part. No. 62131.

Building Laws.

Some Comments on Building Laws. Gunvald Aus. Remarks on engineering points in the New York building code. Elaborated from an address in the Brooklyn Chapter of the Am. Inst. of Archts. 3500 w. Eng News—April 14, 1904. No. 62050.

Central Stations.

The Design and Construction of Buildings Connected with the Generation and Supply of Electricity Known as Central Stations. C. Stanley Peach. Abstract of paper discussing this subject, read before the Royal Inst. of British Architects. 3500 w. Arch't, Lond—April 1, 1904. No. 62-055 A.

Chimneys.

Smokey Chimneys. Hastwell Grayson. Reviews the principles of flues, and the causes of smoky chimneys. 2800 w. Jour Ry Inst of Brit Archts—March 19, 1904. No. 61999 B.

Concrete Construction.

Concrete Construction in Yellowstone National Park. Brief description of work in the roads, bridges and other structures in which concrete has been used. 1800 w. Eng Rec—April 2, 1904. No. 61808.

Concrete-Tanks for Acid Liquor Under Pressure. A. C. Arend. Drawings and explanation. 700 w. Eng News—April 21, 1904. No. 62182.

Concrete Work in Cuba and Yucatan. C. E. McDowell. Gives illustrations of work, with descriptive notes. 1100 w. Munic Engng—April, 1904. No. 62087 C.

Crowds.

Some Recent Tests of the Weight of Crowds. L. J. Johnson. Describes in detail a series of three tests made to determine the weight of crowds per sq. ft. of surface. 1600 w. Eng News—April 14, 1904. No. 62049.

Domes.

Theory of the Spherical Dome with a Homogeneous Surface, and of the Framed Dome; Also Notes on the Construction of Masonry and Metal Domes. Continued discussion of paper on this subject by E. Schmitt. 3200 w. Pro Am Soc of Civ Engrs—March, 1904. No. 62328 E.

Earth Pressures.

Lateral Earth Pressures and Related Phenomena. E. P. Goodrich. Describes experimental investigations made to obtain facts that may be relied upon. 9000 w. Pro Am Soc of Civ Engrs—March, 1904. No. 62324 E.

Earthwork.

Earthwork at the Washington Filtration Works. E. D. Hardy. A report of excavation work, filling, &c. Illustrated. 800 w. Eng Rec—April 16, 1904. No. 62133.

Fireproofing.

The Baltimore Fire. Charles A. Miller, Jr. An illustrated account of this $85,000,000 fire, describing the buildings, and commenting on the lessons to be learned. 6000 w. Archts & Bldrs Mag—April, 1904. No. 61945 C.

The Rochester Conflagration. An illustrated report of the fire of Feb. 26, which destroyed property to the value of $3,200,000. 2800 w. Fire & Water—April 9, 1904. No. 61977.

Foundations.

Safeguarding the Foundations of Trinity Church Spire, New York City. Illustrates and describes methods of protecting these foundations, which are in dry, sandy soil, from undermining during the construction of the rapid transit subway. 700 w. Eng Rec—April 9, 1904. No. 62023.

The Reconstruction of Foundations for the Hotel Wollaton, Brookline, Mass. Dana M. Pratt. Describes the conditions prevailing and the repairs made to render the building safe. Ills. 6800 w. Jour Assn of Engng Socs—March, 1904. No. 62310 C.

Freezing.

Freezing as an Aid to Excavation in Unstable Material. Discussion of a paper by James H. Brace on the above subject. 3800 w. Pro Am Soc of Civ Engrs—March, 1904. No. 62327 E.

Grain Elevators.

Fireproof Grain Storage Elevator for the Canadian Northern Railway, Port Arthur, Ont. R. M. Pratt. From a paper read before Can. Soc. of Civ. Engrs. Descriptive. 3500 w. Can Engr—April, 1904. No. 62035.

Power Production and Transmission in the Stuyvesant Elevator, New Orleans. Describes an elevator with a capacity of 1,500,000 bushels in which the rope system of power transmission was adopted. Ills. 2500 w. Eng Rec—April 9, 1904. No. 62020.

Recent Grain-Elevator Construction (Installations Récentes de Grands Magasins à Blé). A. Bidault des Chaumes. Describing especially the new warehouses at Frankfort, Strasburg, and Genoa, with details of construction. 2000 w. 1 plate. Génie Civil—March 26, 1904. No. 62213 D.

The Canadian Pacific Grain Elevator at Port Arthur, Ontario. Illustrates and describes an elevator designed to meet special conditions, having a capacity of 443,000 bushels, and its construction. 2800 w. Eng Rec—April 9, 1904. No. 62018.

Pile Driving.

Driving a Test Pile for the Hudson River Tunnel. Interesting illustrated description of a test pile driven at Weehawken. 800 w. Sci Am—April 23, 1904. No. 62196.

Roofs.

New Appliances for Re-roofing Shops Without Stopping Work. Describes the work as carried out at Leeds by specially designed machinery. Ills. 1000 w. Sci Am Sup—April 2, 1904. No. 61863.

Shoring.

A Unique Case of Shoring Work on a New York Telephone Building. An illustrated description of method used in enlarging the "Madison Square" Station, in which a brick and iron building was swung up from overhead rather than shored up from below in order to remove certain parts of its walls. 1300 w. Eng News—April 7, 1904. No. 61997.

Tunnels.

The Hudson River Tunnel. An illustrated article, giving briefly the history of this work, begun thirty years ago and now approaching completion. 1800 w. Sci Am Sup—April 2, 1904. No. 61860.

The Originator of the Hudson River Tunnel. Brief review of the early history of this work, calling attention to names deserving record in connection with this undertaking. 1000 w. Eng News—April 7, 1904—No. 61998.

MATERIALS OF CONSTRUCTION.

Brick.

Sand-Lime Brick from a Brickmaker's Point-of-View. Daniel P. De Long. Read at Cincinnati meeting of the Nat. Brick Mfrs. Assn. Discusses the value of this material. General discussion. 4400 w. Am Archt—April 16, 1904. No. 62167.

Cement.

Portland Cement and Its Uses in Engineering Construction. E. Kuichling. The present article reviews the investigations made by S. B. and W. B. Newberry. 3500 w. Munic Jour & Engr—April, 1904. Serial. 1st part. No. 61873 C.

Portland Cement. Presidential address of David Butler Butler before the Soc. of Engrs. (England). On the manufacture, testing, uses, applications, &c. 3200 w. Am Archt—April 2, 1904. No. 61852.

The Fallacy of the Tests Ordinarily Applied to Portland Cement. Richard K. Meade. Read before the Lehigh Valley Sec. of the Am. Chem. Soc. Discusses some of the false conclusions that may be drawn from a too rigid interpretation of the results of tests. 3500 w. Eng Rec—April 2, 1904. No. 61806.

Concrete Plant.

A Concrete Mixing Plant for a Power House Foundation. Illustrated description of the plant for mixing and placing concrete in foundations of power house at Long Island City. 1500 w. Eng Rec—April 9, 1904. No. 62019.

Reinforced Concrete.

Cross-Bending Tests on Steel-Concrete Beams. Illustrates and describes tests made by Prof. Malverd A. Howe of concrete beams reinforced with corrugated steel bars. 1500 w. R R Gaz—April 8, 1904. No. 62003.

Reinforced Concrete Roof for a Locomotive Roundhouse, Long Island R. R. Illustrates and describes the material and methods of construction. 1200 w. Eng News—April 14, 1904. No. 62051.

The Design of Concrete Steel Arches. E. J. McCaustland. Read before the Am. Assn. for the Adv. of Science. Reviews investigations made by W. S. Edge, in an attempt to determine the most economical proportions of the arch ring, and also to investigate the elastic stresses under moving loads with a view of determining the position of loading which will make these stresses a maximum. 2800 w. Eng News—April 21, 1904. No. 62177.

Testing.

Tests of Sand-Lime and Sand-Cement Brick and Concrete Building Blocks. A. Marston. Abstract of a paper read at meeting of the Iowa Brick & Tile Mfrs. Assn. Results of tests are given with explanatory remarks. 800 w. Eng News—April 21, 1904. No. 62184.

Timbers.

Combustibility of Timbers. G. Rodney Cherry. Describes tests made and gives valuable data and tables of comparison. 1500 w. Ins Engng—April, 1904. No. 62367 C.

MEASUREMENT.

Stream Flow.

Canal and Stream Measurements. A. P. Stover. Describes the two methods most commonly employed by engineers—the measuring weir, and the current meter, also briefly notes other methods. 4000 w. Cal Jour of Tech—April, 1904. No. 61970 C.

Method of Computing Daily and Monthly Discharge of Streams with Sandy, Changeable Bed. E. C. Murphy. Brief description of two methods devised by hydrographers of the U. S. Geological Survey for such conditions. 1200 w. Eng News—April 21, 1904. No. 62179.

Surveying.

Practice in Re-establishing and Monumenting a Railway Center Line. Albert I. Frye. Explains a feature which has proved convenient and effective in adjusting the center lines of tangents. 600 w. Eng News—April 14, 1904. No. 62047.

Transit.

Desirable Features in a Transit for Topographical Surveys. George Jacob Davis, Jr. Reviews the requirements of a telemeter and of other improvements introduced, with the hope of aiding in the development of a standard form of stadia instrument. Ills. 1800 w. Eng News—March 31, 1904. No. 61846.

MUNICIPAL.

Pavements.

Street Pavements. Louis M. Pfeiffer. From a paper before the Colorado Polytechnical Assn. Reviews the various materials used, their advantages and disadvantages, and claims much for the bitulithic pavement. 3000 w. Munic Engng—April, 1904. No. 62089 C.

Sewage Disposal.

Notes on the Sewerage System of Worcester, Massachusetts. Concerning the construction work carried on during 1903, and the maintenance and operation of the disposal plant. Ills. 2500 w. Eng Rec—April 23, 1904. No. 62378.

Refuse and Sewage Disposal Station. Col. W. F. Morse. Illustrates and describes a plant at Bolton, England, where power is obtained from sewage, sludge and refuse, with economy. 2000 w. Munic Jour & Engr—April, 1904. No. 61872 C.

Sewage Disposal Works and Experiments at Andover, Mass. An illustrated description of the works and an account of experiments which proved that with the somewhat stale sewage which reached these works septic-tank action was not favorable to subsequent purification. 3500 w. Eng Rec—April 23, 1904. No. 62377.

Sewage Pumping Plant for the Jackson Park Ave. Sewage District at Chicago. Illustrated detailed description. 2500 w. Eng News—March 31, 1904. No. 61847.

Some Observations of Sewage Farming in England. A résumé of facts regarding sewage farming, describing some of the farms visited. 3800 w. Eng News—April 21, 1904. No. 62183.

Sewers.

Extensions of Brooklyn Sewerage System: Avenue G Trunk Sewer. An illustrated detailed description of deep-trench work and sewer construction. 2800 w. Eng Rec—April 16, 1904. Serial. 1st part. No. 62126.

WATER SUPPLY.

Aqueducts.

Geology of the Weston Aqueduct of the Metropolitan Water Works in Southboro, Framingham, Wayland, and Weston, Massachusetts. W. O. Crosby. A record of the character and structure of the hard rocks which were exposed during the construction; especially the geology of the tunnels. Ills. 7000 w. Tech Qr—March, 1904. No. 62358 E.

Petrographical Notes on the Rocks of the Weston Aqueduct. C. H. Warren. Gives results of a microscopical study of some of the igneous rocks met with in the tunnels. Supplementary to paper of W. O. Crosby. 2600 w. Tech Qr—March, 1904. No. 62359 E.

Arid Regions.

Potable Waters in Arid Regions. J. E. Roadhouse. Describes the conditions in Imperial Vallev, Cal., and the problem of preparing pure drinking water. 1800 w. Cal Jour of Tech—April, 1904. No. 61-976 C.

Dams.

Lake Cheeseman Dam and Reservoir. Charles L. Harrison and Silas H. Woodard. The first named gives the history, design and illustrated description of the construction; the second gives an analysis of stresses in Lake Cheeseman dam. 12000 w. Pro Soc of Civ Engrs—March, 1904. No. 62325 E.

Rebuilding the Portman Dam near Anderson, S. C. John L. Sheppard, Jr. Describes the first dam built and its enlargement, and the failure of the composite dam, giving an illustrated description of the rebuilding. 3500 w. Eng Rec—April 2, 1904. No. 61803.

The Barossa Arched Concrete Dam in South Australia. Alex. B. Moncrieff. Illustrated description of the highest arched concrete dam in Australia, with information concerning it. 1000 w. Eng News—April 7, 1904. No. 61991.

The Five Dams and Wood Stave Conduit of the Southern California Mountain Water Co. An outline of the completed and projected works of this company, describing the five dams and giving details of the wood stave conduit. Map and illustrations. 2000 w. Eng News—April 7, 1904. No. 61996.

Derwent Valley.

The Derwent Valley Water Works System, Derbyshire. An illustrated article describing one of the largest supply projects under construction in England. Includes five reservoirs with a combined capacity of 10,000,000,000 imperial gallons, five large masonry dams, nearly 60 miles of conduits and several acres of filters. 3300 w. Eng Rec—April 9, 1904. No. 62016.

Filters.

Levi Mechanical Filters at Charleston-Kanawha, W. Va. Illustrated description of plant of the pressure type. Revolving bars are used to prevent clogging of the screening system by sand. 700 w. Eng News—April 7, 1904. No. 61993.

Ground Water.

Development of an Underground Water Supply for Penzance, England. From a paper by Frank Latham, before the Soc. of Engrs., describing his experiences in this work. 2800 w. Eng Rec—April 16, 1904. No. 62130.

Ithaca, N. Y.

Recent Concrete-Steel Water-Works Construction at Ithaca, N. Y. Illustrated detailed description. 5000 w. Eng Rec—April 9, 1904. No. 62017.

Irrigation.

Irrigation in the North-West Territories of Canada. Showing the importance, extent and value of the work. 900 w. Engr, Lond—March 18, 1904. Serial. 1st part. No. 61937 A.

London.

The London Water-Works Acquirement. R. Price-Williams. A discussion of this undertaking, its extents, capability, and probable benefit to London. 2500 w. Engng—April 15, 1904. No. 62353 A.

Pipe Arch.

The Weston Aqueduct Pipe Arch Over the Sudbury River, Massachusetts. Illustrates and describes the construction of a pipe designed to span the river as a tubular arch to convey water across. 2000 w. Eng Rec—April 16, 1904. No. 62129.

Pollution.

The Value of Tests for Bacteria of Specific Types as an Index of Pollution. Extracts from a special report by H. W. Clark and Stephen De M. Gage in the annual report of the State Board of Health of Massachusetts for 1902. 2000 w. Eng Rec—April 16, 1904. No. 62134.

Protection.

Protection of Water Supplies. J. Cartwright. Presidential address before the Manchester Assn. of Students of the Inst. of Civ. Engrs. Points out sources of pollution, and considers how they may be safeguarded. 2500 w. Sanitarium—April, 1904. No. 62093 D.

Pumping Engines.

See Mechanical Engineering, Hydraulics.

Rainfall.

Rainfall and Run-Off from Catchment Areas in New England. L. M. Hastings. Explains methods of determining the average rainfall, and matters of related interest. Diagrams, tables and discussion. 7000 w. Jour New Eng W. Wks Assn—March, 1904. No. 62097 F.

Reservoirs.

Notes on the Construction of a Storage Reservoir. W. H. Richards. Illustrates and describes such portions of the construction as are somewhat unusual. 1700 w. Jour New Eng W Wks Assn—March, 1904. No. 62098 F.

Progress in Construction of Jerome Park Reservoir, New York City. Information concerning this engineering work with illustrations showing the progress and present condition of the work. 3500 w. Eng Rec—April 23, 1904. No. 62374.

Waste.

Requisite Amount of Water for a Public Supply. J. Herbert Shedd. Discusses the evils of water waste and means of limiting the supply to useful purposes. Gives the experience of Providence, R. I., and facts in regard to the conditions. General discussion. 8400 w. Jour New Eng W. Wks Assn—March, 1904. No. 62095 F.

Water-Works.

Village Water-Works of Geneva, Ohio. Illustrates and describes details of the reservoir and intake, giving plan and section of pumping and filtration plant. 2200 w. Eng Rec—April 2, 1904. No. 61804.

WATERWAYS AND HARBORS.

Breakwater.

The Breakwater at Buffalo, New York. G. H. Raymond and George E. Fell. Continued discussion of a paper on this subject by Emile Low. 2500 w. Pro Am Soc of Civ Engrs—March, 1904. No. 62326 E.

Canal Lifts.

Lifts on the Moravian Canals (Uëber das Schiffsheben auf Mährischen Känälen). Anton Smrcek. Discussing especially the comparative advantages of locks, lifts, and inclined planes for the Danube-Oder canal system. 5000 w. 1 plate. Oesterr Wochenschr f d Oeffent Baudienst—April 9, 1904. No. 62250 D.

Canals.

The Barge Canal Across New York State. Plan showing the route of the canal, with particulars concerning changes, difficulties, etc. 2500 w. R R Gaz—April 8, 1904. No. 62004.

Trent Valley Canal. J. Alexander Culverwell. Map and description of this route which will shorten the transportation from the Great Lakes to the Ocean. It will accommodate barges of 800 tons, and the total cost of the work will be $9,000,000, of which $4,000,000 has been already expended. 1500 w. Can Elec News—April, 1904. No. 62361.

Canal Traction.

Electrical Equipment for Cornwall Canal. F. H. Leonard, Jr. Abstract of paper read before the Can. Soc. of Civ. Engrs. Describes the equipment for lighting and power, which are so liberal as to make navigation at night as easy as by daylight. Discussion. 6200 w. Can Elec News—April, 1904. No. 62360.

Electricity vs. Mule Power on Canals. H. M. Riseley. Illustrated description of an electrical device invented by Stephen W. Wood. 800 w. Sci Am Sup—April 9, 1904. No. 62008.

Dams.

The Cylindrical Movable Dams at Schweinfurt, Germany. A. Steens. Brief illustrated description of a novel type built in a river subject to heavy floods, where a rapid discharge of freshet water was often necessary. 900 w. Sci Am—April 16, 1904. No. 62119.

See also Civil Engineering, Water Supply.

Docks.

The Modern Development of Docks. Brysson Cunningham. Discusses the accommodation for modern ships, recent improvements in docks, etc. Ills. 3500 w. Cassier's Mag—April, 1004. No. 62108 B.

Dredge.

Combination Hydraulic and Dipper Dredge for the Mexican Government. Drawings and particulars of construction furnished by the builders of the dredge

"El Chijol." 2500 w. Eng News—April 21, 1904. No. 62185.

Heysham.

The Heysham Harbour Scheme. Armisted Cay. An illustrated description of the new Midland Railway port, which is nearly completed. 3800 w. Page's Mag—April, 1904. No. 62387 B.

Port.

Proposed Home Shipping Port for Canada. Map and information concerning a scheme to utilize Loch Linnhe, on the west coast of Scotland, stating the advantages. 1300 w. Engr, Lond—March 25, 1904. No. 61939 A.

Reclamation.

Reclamation of the Marshes of New Jersey and Staten Island. Henry Clay Weeks. Explains the present conditions, the value of this land if reclaimed, plans suggested, and a proposed plan of improvement, discussing objections. Map. 3800 w. Eng News—April 7, 1904. No. 61995.

River Improvement.

A Proposed Improvement of the Channel of the Sacramento River. W. L. Huber. Discusses schemes for carrying off the flood water, and reclaiming valuable land. 1200 w. Cal Jour of Tech—April, 1904. No. 61972 C.

Stream Flow.

See Civil Engineering, Measurement.

MISCELLANY.

Land Slide.

A Phenomenal Land Slide. D. D. Clarke. Relates to the slide affecting the reservoirs of Portland, Oregon, describing the surveys and explorations which have been made during the last nine years, for the purpose of determining the dimensions of the slide and its probable cause, and to aid in devising a plan for a cure of the difficulty. Maps, illustrations, etc. 25500 w. Pro Am Soc of Civ Engrs—March, 1904. No. 62323 E.

ELECTRICAL ENGINEERING

COMMUNICATION.

Batteries.

Some Aids in the maintenance of Common-Battery Central Offices. A. Dallam O'Brien. Considers various troubles that annoy and the methods of testing and correcting with promptness. 2000 w. Am Elect'n—April, 1904. No. 61895.

Cable-Laying.

See Marine and Naval Engineering.

Cables.

Recent Submarine Telephone Cables (Ueber Neuere Unterseeische Fernsprechkabel). F. Breisig. Illustrating and describing recent cables laid to connect the North Sea islands with Germany. 5000 w. Elektrotech Zeitschr—March 17, 1904. No. No. 62254 B.

The Localization of Breaks in Submarine Cables. Remarks on reported tests of A. Davidson, concerning the importance of knowing the conditions under which the tests were made. 2500 w. Elec Rev, Lond—April 1, 1904. No. 61943 A.

The Manufacture of Multiple Telephone Cables with Air Insulation. (Die Fabrikation Mehradriger Telephonkabel mit Luftisolation) J. Schmidt. Giving sections of various makes of cables and details of their construction. 3500 w. Zeitschr f Elektrotechnik—April 10, 1904. No. 62267 D.

See also Electrical Engineering, Distribution.

Combination Circuits.

Simultaneous Telephone and Telegraph Equipment. Le Roy W. Stanton. An illustrated article showing the arrangement by the circuit, and the details of the system, and giving information concerning the amount of work already done in the application, and remarks on the effect to be anticipated. 4000 w. Elec Wld & Engr—April 2, 1904. No. 61864.

Exchanges.

Manual vs. Automatic Telephone Exchanges. Howard S. Knowlton. Discusses in detail the disadvantages of the automatic system and the reasons given in its favor. 2200 w. Am Elect'n—April, 1904. No. 61891.

Printing Telegraph.

The Use of Printing Telegraphs in Berlin (Ueber den Ferndruckertrieb in Berlin). Adolf Franke. An extensively illustrated paper describing the workings of the Siemens & Halske system in Berlin. 4000 w. Elektrotech Zeitschr—March 24, 1904. No. 62259 B.

Telegraphy.

Telegraphy in Siberia. L. Lodian. An illustrated article describing the severe conditions which have to be met by the linemen, and the present heavy and responsible work of transmitting war news in cipher. 2000 w. Elec Rev, N. Y.—April 16, 1904. No. 62125.

Telephony.

Telephone Engineering. J. C. Kelsey.

The first of a series of articles reviewing those circuits that have played a prominent part in the development of the telephonic art, and have at one time been a standard form. The present article considers the series grounded system. 2200 w. Elec Rev, N. Y.—April 9, 1904. Serial. 1st part. No. 62010.

Teletyping.

The Berlin Teletyping Central Station. Dr. Alfred Gradenwitz. Illustrates and describes a type-printing telegraph and its operation. 900 w. Elec Rev, N. Y.—April 9, 1904. No. 62012.

DISTRIBUTION.

Boosters.

Booster Calculations. William A. Del Mar. Considers the various conditions controlling the installation and use of boosters. 3000 w. Elec Wld & Engr—April 9, 1904. No. 62031.

Cables.

The Installation of Electric Cables. H. W. Buck. Discusses general principles and suggests directions in which improvements can be made. Ills. 3000 w. Elec Club Jour—April, 1904. No. 62104.

See also Electrical Engineering, Communication.

Conduits.

Electric Conduit Construction at Memphis, Tenn. F. G. Proutt. Describes work done by day labor, the system, etc., giving costs and particulars. Ills. 8000 w. Eng News—April 14, 1904. No. 62052.

Recent Development in Metal Conduits for Electric Light Installations. L. M. Waterhouse. Reviews the kinds of conduit used, and explains the advantages of metal conduits. 2500 w. Elec Rev, Lond —April 1, 1904. No. 61942 A.

Converters.

Synchronous Converters. F. G. Baum. An explanation of the theory of operation of converters. Gives the characteristic regulation curves of a small polyphase converter when employed as a shunt machine, and when compounded. 3000 w. Elec Wld & Engr—April 9, 1904. No. 62032.

Faults.

Localization of Faults on Low-Tension Networks. W. E. Groves. Read at Birmingham before the Inst. of Elec. Engrs. Remarks referring particularly to a three-wire low-tension network, with the neutral earthed at the generating station or substation through a resistance of 2 ohms. 2800 w. Elec Rev, Lond—April 8, 1904. Serial. 1st part. No. 62155 A.

Insulators.

The Inflammability of Rubber Insulating Tape (Ueber die Entflammbarkeit Biegsamer Gummibandschnüre). J. Herzog and C. Feldmann. With diagram giving the results of tests as to the extent to which the conductor may become heated without igniting the insulation. 1000 w. Elektrotech Zeitschr—March 17, 1904. No. 62252 B.

Mains.

Economy in Electric Mains. Discusses the devices and systems aiming at a reduction of cost, with the view of showing their reliability or unreliability. 1500 w. Elec Engr, Lond—April 1, 1904. No. 62-064 A.

Sub-Stations.

Energy Distribution to Sub-Stations. C. Alfred Smith. Abstract of a paper read before the Birmingham Loc. Sec. of the Inst. of Elec. Engrs. Compares the cost of two different systems. In the first the power is transmitted electrically from a gas engine station and distributed by means of sub-stations; in the second the gas is transmitted to gas-engine sub-stations, other conditions remaining the same. 6000 w. Elec'n, Lond—April 1, 1904. No. 62-067 A.

Wiring.

Electric Wiring of Machine Tools. O. W. Bodler. Shows the way of determining the size of the wire, and forms of wiring. Ills. 1200 w. Ry Mas Mech—April, 1904. No. 61853.

ELECTRO-CHEMISTRY.

Cadmium.

Notes on the Electro-Deposition of Cadmium and Its Alloys. Sherard Cowper-Coles. Reports results of investigations made. 2500 w. Elec-Chem & Met—March, 1904. No. 62322 C.

Electro-Metallurgy.

The Applications of Electricity to Metallurgy. Joseph W. Richards. Classifies the electro-metallurgical processes and explains the principles on which they are based. 6600 w. Tech Qr—March, 1904. No. 62357 E.

Steel.

The Electrical Manufacture of Steel. Gustave Gin. Abridged translation of M. Gustave Gin's description of his latest process for the production of steel by electrical means. 3500 w. Elec-Chem & Met —March, 1904. No. 62321 C.

ELECTRO-PHYSICS.

Distortion.

Distorted Alternating and Rotating Magnetic Fields. R. Goldschmidt. A study of the effect of distorted voltage, illustrating by example. 1200 w. Elec Rev—April 8, 1904. Serial. 1st part. No. 62154 A.

Eddy Currents.

Eddy Current Losses (Ueber Wirbelstromverluste). F. Niethammer. Deriving working formulas for the computation of losses, with practical applications. 1200 w. Zeitschr f Elektrotechnik—April 3, 1904. No. 62266 D.

Eddy Currents in Cable Sheaths. M. B. Field. Read before the Inst. of Elec. Engrs. A theoretical consideration of the currents induced in cable sheaths and the losses occasioned thereby. 4700 w. Elect'n, Lond—April 15, 1904. Serial. 1st part. No. 62338 A.

Radio-Activity.

The Practical Uses of Radiant Energy. Discusses the theories of light and heat, and their practical applications. 2500 w. Jour Gas Lgt—April 12, 1904. No. 62-189 A.

Radio Activity of Certain Minerals and Mineral Waters. R. J. Strutt. Read before the Royal Soc. Gives results of an examination of certain radio-active materials, describing method used. 3000 w. April 1, 1904. No. 62066 A.

Recent Discoveries in Radiation and Their Significance. R. A. Millikan. Reviews recent discoveries of new rays, and their relation to the question of the nature and constitution of matter. 7500 w. Pop Sci M—April, 1904. No. 62084 C.

Radium.

Contributions to Our Knowledge of Radium. W. Marckwald. Trans. from *Berichte der Deutsch. Chem Gesell.* Considers the separation of radium from barium, the phosphorescence of the anhydrous radium-barium chloride, and induced radio-activity. 1200 w. Sci Am Sup—April 23, 1904. No. 62303.

Radium. Translated from the French of Jacques Danne, in *Le Génie Civil.* An account of the discovery and description of methods of research. Ills. 4500 w. Sci Am Sup—April 9, 1904. Serial. 1st part. No. 62007.

The Wonderful New Element, Radium. E. Booth. The substance of a popular lecture delivered at the Univ. of California. 3600 w. Cal Jour of Tech—April, 1904. No. 61974 C.

Shielded Balance.

The Shielded Balance. G. A. Campbell. Aims to show how the source of error when alternating current is employed may be entirely eliminated by shielding. 2500 w. Elec Wld & Engr—April 2, 1904. No. 61867.

Solenoids.

Predetermining Solenoid Characteristics. William A. Del Mar. Considers the design of a solenoid for tractive work, illustrating by examples which show that the gradient formula gives results which agree fairly well with practice. 2000 w. Am Elect'n—April, 1904. No. 61893.

Thermo-Electricity.

Thermo-Electric Forces in a Heated Wire (Thermoelektrische Kräfte in einem Erwärmten Draht). F. Schneider. A review of the experiments of Egg-Sieberg, showing that the origin of the current in a heated wire is the formation of oxide. 1500 w. Elektrotech Zeitschr—March 24, 1904. No. 62258 B.

GENERATING STATIONS.

Alternators.

A Contribution to the Theory of the Regulation of Alternators. H. M. Hobart and F. Punga. Discussion, with formulæ and diagrams. 7500 w. Trans Am Inst of Elec Engrs—April 22, 1904. No. 62-187 D.

A General Diagram for Alternators. Gives an explanation of Prof. F. Niethammer's method of pre-determining the characteristics of alternating-current machinery by graphical means, which has been found to give accurate results in practice. 1400 w. Elect'n, Lond—April 15, 1904. No. 62339 A.

The Mechanical Construction of Revolving-Field Alternators. David B. Rushmore. Paper before the Am. Inst. of Elect. Engrs., with illustrations and diagrams. 7700 w. Trans Am Inst of Elec Engrs—April 22, 1904. No. 62186 D.

Economy.

Central-Station Economy. F. H. Davies. Calls attention to many small losses in central-station practice which, if corrected, would aggregate a considerable saving. 3300 w. Elec Engr, Lond—April 15, 1904. No. 62335 A.

Heat Losses.

Joule Heat Losses in a Cage Armature (Verluste durch Joulesche Wärme in einem Käfiganker). F. Punga. Developing formulas for computing the heat losses in armatures of the squirrel-cage type. 1200 w. Zeitschr f Electrotechnik—March 27, 1904. No. 62265 D.

Hydro-Electric.

Hydroelectric Power Plant at Zwolfmalgreien, in Tyrol, Austria. Franz Koster. Illustrated detailed description. 3200 w. Elec Rev, N. Y.—April 2, 1904. No. 61801.

The Atlanta Water & Electric Power Company's Plant at Morgan Falls. Illustrated description of a plant comprising a large masonry dam, a fireproof powerhouse equipped with horizontal turbines and large alternating current generators, and a high-voltage transmission line. 4500 w. Eng Rec—April 23, 1904. No. 62372.

The Electric Station at Kubel, near St. Gall (Das Elektrizitätswerk Kubel bei St. Gallen). L. Kürsteiner. A fully illustrated description with details of the dam, canal, and electric generating and distributing plant. Serial. Part I. 1500 w. Schweizerische Bauzeitung—April 2, 1904. No. 62230 D.

The Hydroelectric Station of Champ. Enrico Bignami. Illustrated description of an industrial power station in the province of Isère, erected and operated by local interests. 2500 w. Elec Rev, N. Y.—April 9, 1904. No. 62011.

The Location of Electric Water-Power Stations. Alton D. Adams. Illustrates and describes examples of American practice. 3500 w. Cassier's Mag.—April, 1904. No. 62109 B.

Water Power Transmission Plant at Elliott's Falls, Ontario. Charles L. Fitch. Illustrates and describes the plant which is to furnish power for the Raven Lake Portland Cement Company. 2000 w. Elec Wld & Engr—April 2, 1904. No. 61865.

Inspection.

Inspection of Plants. George A. Burnham. The present paper considers dynamos and connections. The object is to point out the troubles which are liable to occur, and a simple and efficient method of locating and remedying them. Ills. 1600 w. Engr, U S A—April 1, 1904. Serial. 1st part. No. 61859 C.

Port Huron.

Steam Turbine and Other Features of the Port Huron Light and Power Company's Station. James E. Davidson. An illustrated description of this company's installation of the Curtis steam turbine, with a review of the general conditions of the station. 6500 w. Elec Wld & Engr—April 9, 1904. No. 62030.

Ship Equipment.

See Marine and Naval Engineering.

West Ham.

New Electricity Works at West Ham. Illustrated description of this new electric generating station which is one of the largest English municipal undertakings. 3500 w. Elect'n, Lond—April 1, 1904. No. 62065 A.

Windings.

The Production of Pure Sine Currents (Ueber die Erzeugung Reiner Sinusströme). Reinhold Rüdenberg. Discussing methods of winding by which an exact sine curve may be produced when such is desired. 2500 w. Elektrotech Zeitschr—March 31, 1904. No. 62261 B.

LIGHTING.

Arcs.

A Contribution to the Study of the Electrical Arc. Dr. William S. Weedon. Read at Washington meeting of the Am. Elec. Chem. Soc. Considers only direct-current arcs. A report of experimental investigations. 4000 w. Elec Rev, N. Y.—April 23, 1904. No. 62370.

Improvements in Electric Arc Street Lighting. H. W. Hillman. From a paper read before the Am. Soc. of Munic. Imp. Illustrated descriptions of recent work, showing the great improvement in appearance. 1500 w. Munic Engng—April, 1904. No. 62088 C.

Chronophotography.

The Application of the Electric Spark to the Chronophotography of Rapid Movements (Application de l'Etincelle Electrique à la Chronophotographie des Mouvements Rapides). Lucien Bull. Describing an apparatus for enabling cinematograph photographs to be taken at very close intervals of time. 1000 w. Comptes Rendus—March 21, 1904. No. 62228 D.

Electricity vs. Gas.

New Lamps for Old. R. J. Milbourne. Reviews the progress of electricity, and gives a comparison of costs in favor of gas. 3300 w. Jour Gas Lgt—April 12, 1904. No. 62191 A.

Photometry.

The Various Methods of Measuring Illumination (Die Verschiedenen Methoden der Helligkeitsprüfung). A. Wingen. A description of the various scientific and practical methods of measuring the intensities of artificial lights. 4500 w. Gesundheits-Ingenieur—April 10, 1904. No. 62245 D.

See also Gas Works Engineering.

MEASUREMENT.

Condensers.

The Application of Condensers in the Measurement of Alternating Current (Ueber die Verwendung von Kondensatoren bei Wechselstrommessungen). W. Peukert. Discussing the use of condensers for lowering the voltage in high-tension measurements. 2000 w. Elektrotech Zeitschr—March 24, 1904. No. 62256 B.

Diagrams.

Diagrams for the Compensated Series Motor (Diagramme für den Kompensierten Serienmotor). M. Osnos. Developing graphical diagrams for determing the voltage relations at various speeds. 4500 w. Elektrotech Zeitschr—March 17, 1904. No. 62251 B.

The Cascade Diagram for Speeds above Synchronism (Das Kaskadendiagramm für Uebersynchronismus). Paul Müller. Discussing the modifications necessary in the circle diagram for induction motors operated in cascade when the speed is above synchronism. 1800 w. Elektrotech Zeitschr—March 24, 1904. No. 62257 B.

Efficiency Determination.

Finding Dynamo Efficiency by the Electrical Method. F. C. Caldwell. Describes methods of determining the various classes of losses. 2800 w. Engr, U S A—April 1, 1904. No. 61858 C.

The Efficiency Curves of Constant-Potential Transformers. A. E. Kennelly. A treatment of this subject stating the assumption made and concluding the efficiency curve is an acute hyperbola, having for one of its asymptotes a straight line representing only the copper loss. 1200 w. Elec Wld & Engr—April 16, 1904. No. 62141.

Errors.

The Errors of Instruments. George T. Hanchett. Showing that a recording wattmeter is subject to errors of voltage, and cannot be used on any voltage promiscuously. 1200 w. Cent Sta—April, 1904. No. 62013.

Galvanometers.

Electrical Measuring Instruments. S. S. Edmonds. The present article illustrates and describes three types of galvanometer. 2200 w. Engr, U S A—April 15, 1904. Serial. 1st part. No. 62137 C.

Measuring Instruments.

Direct Reading Measuring Instruments for Switchboard Use. Kenelm Edgecombe and Franklin Punga. Abstract of a paper read before the Inst. of Elec. Engrs. Describes the chief types of switchboard measuring instruments and the electrical errors. 5000 w. Elect'n, Lond—March 25, 1904. Serial. 1st part. No. 61932 A.

Meters.

A Phase Meter (Ein Phasenmesser). A. Grau. Describing an arrangement of an alternating-current wattmeter so that it will indicate the power factor and enable the difference of phase to be found. 1000 w. Elektrotech Zeitschr—March 31, 1904. No. 62260 B.

Motor Testing.

A Test for Induction Motor Windings. G. H. Garcelon. Describes a test based upon the fact that any error in the winding will destroy the symmetry of the magnetic field produced by the winding when single-phase alternating-current is passed through it. Ills. 2200 w. Elec Club Jour—April, 1904. No. 62106.

Dynamo and Motor Testing. C. F. Smith. Abstract of a paper read before the Civil and Mech. Engrs. Soc. Deals with the equipment of a test house, and methods of testing. 2200 w. Prac Engr—April 8, 1904. No. 62164 A.

Tests of Motor Driven Roller Tables at Duquesne. Albert Kingsbury. Describes tests made to determine data for use in estimating the sizes of motors required in this class of service. 3000 w. Ir Age—March 31, 1904. No. 61823.

Notation.

A System of Fundamental Notation (Einheitliche Formelzeichen). K. Strecker. Suggestions for a general system of fundamental notation of physical quantities. 10,000 w. Elektrotech Zeitschr—March 31, 1904. No. 62262 B.

Ondograph.

The Hospitalier Ondograph. Illustrated description of this instrument for tracing directly the wave forms of variable currents. 1200 w. Sci Am Sup—April 23, 1904. No. 62301.

Power Curves.

Theoretical Determination of Power Curves. Gives communications from V. R. Heftler, John C. Parker, Bassett Jones, Jr., and Frank R. Stowe, having for their subject the article by W. J. Berry, which appeared in the issue of Jan. 30. 1000 w. Elec Wld & Engr—April 16, 1904. No. 62142.

Timing.

Electric Timing Arrangement on the "Cresta" at St. Moritz. An illustrated description of the apparatus for timing the racing on this celebrated toboggan run. 1100 w. Elec Rev, Lond—April 1, 1904. No. 61941 A.

New Electric Chronometer for Timing Automobiles. Illustrates and describes an ingenious electric apparatus and its operation. 900 w. Sci Am—April 23, 1904. No. 62197.

MOTORS.

Canal Traction.

See Civil Engineering, Waterways.

Design.

Construction of a 2-H. P. Motor or 25-Light Incandescent Dynamo. F. C. Mason. Drawings with explanatory notes. 2500 w. Am Elect'n—April, 1904. No. 61894.

Driving.

The Adaptability of Electrical Driving. B. Longbottom. Abstract of a paper read before the Manchester Assn. of Engrs. Considers the mechanical forms of power distribution, giving tabulated results of tests, and furnishing means of comparison between mechanical and electrical distribution, and information concerning the advantages. 3000 w. Elect'n, Lond—April 8, 1904. No. 62157 A.

See Mechanical Engineering, Machine Works and Foundries.

Dynamos.

Design of Small Dynamos. J. W. Burleigh. Illustrates the course adopted by the writer, giving briefly the principal formulæ used in determining the results. 1000 w. Elec Rev, Lond—April 8, 1904. No. 62156 A.

Induction Motors.

The Induction Motor. Explains the principle of the induction motor, its operations, with diagrams and illustrated descriptions of some forms. 9500 w. Harvard Engng Jour—April, 1904. Serial. 1st part. No. 62391 D.

Mining Plant.

See Mining and Metallurgy, Mining.

Motor Testing.

See Electrical Engineering, Measurement.

Rolling Mills.

See Mining and Metallurgy, Iron and Steel.

Single-Phase.

Single Phase Commutator Motors (Die Einphasigen Kommutatormotoren). J. K. Sumec. An elaborate mathematical study, employing both analytical and graphical methods. Serial. Part I. Zeitschr f Elektrotechnik—March 20, 1904. No. 62264 D.

Single-Phase Motors as a Means of Increasing Station Earnings. W. A. Layman. Presented at meeting of the Ohio, Colorado, and Southwestern Electric Light Assn. Shows ways in which the single-phase, alternating-current motor lends itself to power distribution and economical service. Describes the Wagner single-phase motor. Ills. 3000 w. Jour of Elec —April, 1904. No. 62149 C.

The Westinghouse Single-Phase Motor. Illustrated description of this alternating-current series motor. It is claimed that by a simple change in the controller the motor can be operated by direct current. 1100 w. R R Gaz—April 8, 1904. No. 62002.

Variable Speed.

Variable Speed Motors. J. W. Burleigh. Shows the writer's method of design of motors capable of withstanding large variations of speed. 900 w. Elec Rev, Lond—March 25, 1904. No. 61931 A.

Variable Speed Motors. William Baxter, Jr. Illustrated description of types made by the General Electric Co. 2500 w. Mach, N. Y.—April, 1904. Serial. 1st part. No. 61811 C.

TRANSMISSION.

High Voltage.

Some Problems in Electrical Engineering Due to the Conductivity of the Atmosphere. Harris J. Ryan. An analysis of the factors that produce the energy losses through the atmosphere in high-voltage lines. 5000 w. Sib Jour of Engng—April, 1904. No. 62307 C.

Long Span.

A Long-Span Transmission Line. B. Wiley. Describes a power line from the Carrie furnaces to the Homestead Steel Works, the particular feature being a span of 1000 feet between supports. Ills. 1300 w. Elec Wld & Engr—April 16, 1904. No. 62140.

MISCELLANY.

Laboratory.

The Laboratoire Central D'Electricité at Paris. Albert Campbell. A description of some of the things seen in the main public laboratory for electrical testing work. 1200 w. Elec Rev, Lond—March 25, 1904. No. 61929 A.

Law.

Electricity and the Law in England and America. W. Valentine Ball. A comparison of the two countries as regards liabilities of supply companies. 3400 w. Elec Wld & Engr—April 2, 1904. No. 61866.

Loft Buildings.

Loft-Buildings—Electric Power Desirable. E. R. Knowles. States the conditions in large cities which have led to the growth of the modern loft building, its requirements, etc. 1500 w. Elec Rev, N. Y.—April 2, 1904. No. 61802.

GAS WORKS ENGINEERING

Brentwood.

The Brentwood Gas-Works: As They Were and as They Are. Illustrated detailed description. 4500 w. Jour Gas Lgt —April 12, 1904. No. 62190 A.

Business Practice.

Gas Engineering. W. A. Baehr. A lecture before the students of the Univ. of Wis. Describes the engineering features of the business, the manufacture and distribution. 8000 w. Wis Engr—April, 1904. No. 62094 D.

Chemistry.

A Brief Outline of Gas-Works Chemistry. H. B. Harrop. Read at meeting of Wis. Gas Assn. An outline of a desirable course, intended to give practical help to gas-workers. 12500 w. Pro Age—April 1, 1904. No. 61799.

Meters.

Care of Station Meters. Henry R. Cartwright. Gives details of the care needed. Short discussion. 2000 w. Pro Age—April 15, 1904. No. 62083.

Mixed Gas.

Besemfelder's Mixed-Gas Process. Abstract translation of a paper by the inventor giving particulars of the advantages of this process for a continuous production of a mixed gas of uniform composition. 3000 w. Jour Gas Lgt—April 12, 1904. No. 62192 A.

Outputs.

Why English Gas Outputs Are Large, with Lessons to Be Drawn in the United States. J. T. Westcott. Tabulated information concerning representative towns in different countries, with explanation of conditions in England. General discussion. 3300 w. Pro Age—April 15, 1904. No. 62082.

Photometry.

Flicker Photometry in Its Relation to Sources of Light of Different Colors. Dr. Hugo Krüss. Summary of an address to the Lower Saxon Assn. An account of investigation, with the author's conclusions. 2300 w. Gas Wld—March 26, 1904. No. 61927 A.

See also Electrical Engineering, Illumination.

Progress.

Progress Department Report, at Meeting of Ohio Gas Light Association. Irvin Butterworth. A résumé of the more important technical and mechanical improvements that have been made in gas manufacture, distribution and consumption during the last year. Short discussion. 9500 w. Am Gas Lgt Jour—April 25, 1904. No. 62362.

Purification.

Economy in Oxide Purification. H. L. Rice. Read before the Ohio Gas Lgt. Assn. Calls attention to results achieved under rather unusual conditions at the Norfolk (Va.) works. 5300 w. Am Gas Lgt Jour—April 11, 1904. No. 62027.

Purifying Materials and Spent Oxide. P. Parrish. Considers oxides of iron and spent oxide as purifying materials for coal gas. General discussion. 7000 w. Gas Wld—April 2, 1904. No. 62057 A.

Purifiers.

A New Development in Purifier Grids. F. D. Marshall. Illustrates and describes the "Standard" grid, reviewing investigations that led to its development. 2000 w. Gas Wld—April 2, 1904. No. 62059 A.

Small Plant.

Design of a Small Coal Gas Plant. Alfred G. Lloyd. Read at meeting of Wis. Gas Assn. Considers plants serving 10,000 people or less. Ills. 3500 w. Pro Age—April 1, 1904. No. 61798.

Street Lighting.

The Use of High Pressure Gas on Street Lighting. J. J. Knight. Read before the Ohio Gas Lgt. Assn. Comments on the best means of street lighting now available, with a report of the writer's views on high-pressure service. Also general discussion. 3500 w. Am Gas Lgt Jour—April 11, 1904. No. 62026.

Sulphur.

Sulphur Purification. O. W. Dougan. Abstract of a paper read before the Junior Gas Assn. Discusses the theory and practice, testing, etc. 4000 w. Gas Wld—April 2, 1904. No. 62058 A.

INDUSTRIAL ECONOMY

Apprentices.

What Manchester is Doing for Engineering Apprentices. F. Brocklehurst. An account of the work which is being done in the great electrical and mechanical trade school at Manchester. 3000 w. Engineering Magazine—May, 1904. No. 62276 B.

Contracts.

Uncompleted Works. Discusses questions in English law affecting contracts. 1800 w. Elec Rev, Lond—April 1, 1904. No. 61944 A.

Cost Keeping.

Cost Keeping and Shop Statistics for a Repair Shop. A. W. Thompson. Describing the working of a practical system in the repair shops attached to a large mill corporation and well adapted for recording a varied line of work. 3000 w. Engineering Magazine—May, 1904. No. 62-273 B.

Education.

Resumed Discussion on Mr. Max Wurl's Paper on "Technical Education in Germany." Plate. 11000 w. Trans N-E Coast Inst of Engrs & Shipbuilders—March, 1904. No. 62318 D.

The Technical Graduate and the Machinery Department of Railroads. W. F. M. Goss. Outlines the development of the technical graduate, his training, etc., and considers some of the defects in the administration of special apprenticeship, and the remedy. General discussion. 12500 w. Pro W. Ry Club—March 15, 1904. No. 62101 C.

Foreign Trade.

A Comparison of American and European Commercial Conditions. W. J. Clark. A discussion of the economic and industrial factors affecting trade with the United States and other parts of the world. 4000 w. Engineering Magazine—May, 1904. No. 62270 B.

Germany.

The Industrial Advance of Germany. Joseph Horner. An English view of the causes and effects, facts and features. 7000 w. Cassier's Mag—April, 1904. No. 62110 B.

Labor.

Equitable Labor Compensation and Maximum Output. H. L. Gantt. Describes the principles on which the bonus system is founded, and the way in which it is carried out. 3500 w. Cassier's Mag—April, 1904. No. 62111 B.

Exact Time Study as the Basis of Pay for Work Done. H. L. Gantt. Read at the Philadelphia meeting of the Nat. Metal Trades Assn. A discussion of the difficulties in satisfactorily adjusting the price of labor, and the effect on the output of plants. 2800 w. Ir Trd Rev—March 31, 1904. No. 61800.

The Industrial Army of the United States. James Dredge. The present article gives information based on the U. S. census, in regard to the population and its distribution, the extent of territory, etc. 4000 w. Trac & Trans—April, 1904. Serial. 1st part. No. 62079 E.

Organization.

The Employers' Association of the Future. Henry M. Leland. Prepared for the Nat. Metal Trds. Assn. A discussion of the attitude of labor and capital and the future outlook, with suggestions as to the steps needed. 4500 w. Ir Trd Rev—April 7, 1904. No. 61985.

Specifications.

A Schedule of General Clauses to Be Used as a Guide in Drawing Specifications. 3000 w. Eng News—April 21, 1904. No. 62178.

Steel Trust.

The German Steel Trust (Der Deutsche Stahlwerksverband). An editorial note giving the list of firms forming the combination of steel makers in Germany, with an abstract of the articles of their agreement. 1500 w. Stahl u Eisen—March 15, 1904. No. 62215 D.

Stock Tracing.

Card Systems and Diagrams—Keeping Track of Stock—Factory Management. J. S. V. Bickford. An interesting discussion of the topics named. 2200 w. Am Mach—April 14, 1904. No. 62042.

Subsidies.

Merchant Cruisers and Steamship Subsidies. Lord Brassey. Read before the Inst. of Naval Archts. Urges a more liberal expenditure on subsidies to fast ocean services. 1500 w. Engng—April 1, 1904. No. 62075 A.

Wage Methods.

Wage Paying Methods from the Viewpoint of the Employer. Henry Hess. Mr. Hess's second paper examines the wage problem from the employer's side of the question, illustrating the results of various plans by the graphical method. 3000 w. Engineering Magazine—May, 1904. No. 62271 B.

MARINE AND NAVAL ENGINEERING

Battleships.

A New Japanese Battleship. Particulars of a vessel now building at Elswick Shipyard for the Imperial Japanese Navy. Ills. 3800 w. Engr, Lond—April 8, 1904. No. 62162 A.

The Battleships "Triumph" and "Swiftsure," late "Libertad" and "Constitution." Sir Edward J. Reed. Read at the Inst. of Naval Archts. Explains the steps that led to the construction of these ships, giving particulars, and describing design, armament, etc. 5000 w. Engng—March 25, 1904. No. 61936 A.

Bulkheads.

Longitudinal Engine-Room Bulkheads in Merchant Vessels, in Relation to Transverse Stability When Bilged. F. H. Alexander. Read before the N. E. Coast Inst. of Engrs. and Shipbuilders. The object of the paper is to show the possible effect on the transverse stability of a ship, if one side of the engine space were flooded. Ills. 3000 w. Prac Engr—April 8, 1904. No. 62163 A.

Cable Laying.

The Twin-Screw Cable-Laying Steamer "Stephan." An illustrated detailed description of the second German cable steamer. 2800 w. Engng—March 25, 1904. Serial. 1st part. No. 61935 A.

Car Ferry.

Pere Marquette 19: A Car Ferry of the Largest Size. Illustrated detailed description. 1000 w. Marine Engng—April, 1904. No. 61818 C.

The Danish Steam Car Ferry "Prins Christian." Illustrates and describes a vessel built to complete the new direct route between Berlin and Copenhagen. 1300 w. Marine Engng—April, 1904. No. 61817 C.

Colliers.

Steam Colliers. Reviews the development of the cargo steamer from the steam colliers employed in coasting and cross-channel work. 2500 w. Col Guard—April 1, 1904. No. 62068 A.

Electrical Equipment.

The New White Star Steamer Baltic's Electrical Equipment. George E. Walsh. Describes some of the electrical devices of this vessel, which has the most extensive electrical equipment yet installed. 1300 w. Elec Rev, N. Y.—April 16, 1904. No. 62124.

Experimental Tanks.

A National Experimental Tank. Sir William H. White. Read before the Inst. of Naval Archts. A proposal for the establishment of a national experimental tank, to be chiefly devoted to research work in connection with fluid resistance and ship-propulsion. 6500 w. Engng—April 1, 1904. No. 62073 A.

Some Results of Model Experiments. R. E. Froude. Describes a series of resistance experiments on systematic variations in form of hull, giving results. 4200 w. Engng—April 1, 1904. No. 62071 A.

Ferryboats.

New Screw Ferryboats. Illustrated detailed description of craft designed for use by the City of New York for the Staten Island ferry. 3800 w. Naut Gaz—March 31, 1904. Serial. 1st part. No. 61870.

Hull Protection.

Ships' Compositions. A. C. A. Holzapfel. Read before the Inst. of Naval Archts. Discusses the large number of compositions for the protection of ships, details of their manufacture, and the chemical processes upon which their efficacy depends, and other attempts at protecting vessels. 3800 w. Engng—April 8, 1904. Serial. 1st part. No. 62161 A.

Japanese Navy.

Engineering in the Japanese Navy. Engineer-Rear-Admiral Miyabara. Read before the Japanese Soc. of Naval Archts. Translated by Prof. S. Terano. Outline description of recent developments of marine engineering in the Japanese navy, with special reference to Miyabara's patent water-tube boiler. Ills. 4300 w. Engng—April 15, 1904. No. 62354 A.

Marine Engines.

See Mechanical Engineering, Steam Engineering.

Motor Boats.

Gas and Oil Engines for Marine Propulsion. John E. Thornycroft. Read at meeting of the Inst. of Nav. Archts. Considers the different systems and the way in which they work. Ills. 2300 w. Mech Engr—April 2, 1904. No. 62060 A.

Gasoline Engines for Fast Boats. Herbert L. Towle. Discusses the principles governing the construction of the high-power launch, and problems related. 2000 w. Am Mach—April 21, 1904. No. 62168.

Motor Boat Races in France. Remarks on the races at Monaco Bay, with illustrations of boats. 1500 w. Engr, Lond—April 15, 1904. No. 62345 A.

1904 Rating of French Motor Boats. A résumé of rules controlling motor boat-racing in French waters. 1000 w. Auto Jour—March 26, 1904. No. 61922 A.

Oscillations.

The Gyroscopic Effect of Flywheels on Board Ships. Herr Otto Schlick. Read before the Inst. of Naval Archts. Describes an appliance, proposed by the writer, the employment of which makes it possible not only to increase the period of oscillation of a vessel, but also to lessen her angle of heel. It depends in principle on the gyroscopic action of a rapidly rotating flywheel. Ills. 5300 w. Engng—April 1, 1904. No. 62074 A.

Propellers.

An Inquiry Regarding the Marine Propeller. J. Millen Adam. Continued discussion. 2000 w. Trans Inst. of Engrs. & Shipbuilders of Scotland—Feb. 23, 1904. No. 62316 D.

Marine Propellers with Non-Reversible Engines and Internal Combustion Engines. Rankin Kennedy. Discussion of this paper. 3400 w. Trans Inst of Engrs & Shipbuilders of Scotland—Feb. 23, 1904. No. 62-315 D.

Propulsion.

The Problem of Screw Propulsion. Arthur Rigg. An explanation of the writer's theory concerning screw propulsion, and giving an account of tests which led to it. 2500 w. Engr, Lond—April 15, 1904. Serial. 1st part. No. 62343 A.

Rolling.

The Theory of the Schlick Cycle (Die Theorie des Schlickschen Schiffskreisels).

A. Föppl. An examination into the theory of Otto Schlick concerning the periodical effect in the rolling of ships. 4500 w. Zeitschr d Ver Deutscher Ing—April 2, 1904. No. 62205 D.

Rudder Pressures.

The Normal Pressures on Thin Moving Plates. A. W. Johns. Abstract of paper read before the Inst. of Naval Archts. Gives results of experimental investigations in air and in water. 2000 w. Engr, Lond—April 15, 1904. No. 62350 A.

Stability.

Notes on the Construction of Stability Cross Curves from Balanced Paper Sections. John H. Heck. An explanation of methods of calculating the stability of ships. Short discussion. 5 plates. 4200 w. Trans N E Coast Inst of Engrs and Shipbuilders—March, 1904. No. 62319 D.

Steamer.

New Steamer for the Coast Survey. Illustrated description of a new single-screw steamer designed for the requirements of the duty. 500 w. Marine Rev—March 31, 1904. No. 61868.

New Steamship Mongolia, for the Pacific Mail Steamship Company. Illustrated description of a recently completed vessel. 6000 w. Marine Engng—April, 1904. No. 61815 C.

The Twin Screw Freight and Passenger Steamship "Gnesenau" (Der Doppelschrauben Fracht und Passagierdampfer "Gneisenau"). Hermann Hildebrandt. A very complete description of a new 15,000-ton vessel of the North German Lloyds. 5000 w. 3 plates. Zeitschr d Ver Deutscher Ing—April 9, 1904. No. 62208 D.

Submarine Mines.

The Submarine Mine. Describes the three different kinds of submarine mines, giving illustrations showing the principles upon which they are built and operated. 1500 w. Sci Am—April 23, 1904. No. 62199.

Torpedoes.

The Torpedo in Warfare. Herbert C. Fyfe. An illustrated article giving the history of the "Whitehead" torpedo. 2200 w. Engng Times—March, 1904. No. 62384 B.

Turbine Propulsion.

Steam Turbines for High-Speed Cunarders. Editorial on the decision of the Cunard Company to adopt steam turbines on their two new high-speed liners. 2000 w. Engng—April 1, 1904. No. 62072 A.

Steam Turbine Propulsion for Marine Purposes. Prof. A. Rateau. Considers the principal difficulties in applying turbines to the propulsion of ships, and the details of the two applications made of the Rateau steam turbines. 5700 w. Mech Engr—April 2, 1904. No. 62061 A.

See also Mechanical Engineering, Steam Engineering.

Unsinkable Vessels.

A New Invention for Rendering Vessels Unsinkable. Herbert C. Fyfe. Illustrates and describes the new Stone-Lloyd hydraulically-controlled marine safety bulkhead doors for rendering vessels unsinkable as installed on the "Deutschland," and their method of working. 2500 w. Sci Am Sup—April 16, 1904. No. 62123.

MECHANICAL ENGINEERING

AUTOMOBILES.

Alcohol.

Alcohol as a Motive Power. W. R. Ormandy. Arguments showing alcohol to be a suitable motor fuel, and in some respects the most suitable fuel, and giving proofs of its practical possibilities. 5000 w. Motor Car Jour—April 2, 1904. No. 62054 A.

Clutches.

Friction Clutches on Automobiles. Reproduction from the *Horseless Age* of a translation from *La France Automobile,* giving a review of French practice in this feature of automobile design. Ills. 3000 w. Mech Engr—April 9, 1904. Serial. 1st part. No. 62153 A.

Exhibition.

Agricultural Hall Show. A review of the principal novelties, aiming to describe particularly things not previously exhibited or described. Ills. 10300 w. Autocar—March 26, 1904. Serial. 1st part. No. 61923 A.

Fire Engines.

Automobile Fire Engines. Emile Guarini. Illustrates some foreign engines, describing a recent engine for the fire department of Paris. 1100 w. Sci Am Sup—April 16, 1904. No. 62121.

Highway Law.

The Use of the Highway. A. Moresby White. Read at the British Auto. Club. A résumé of English law as affecting highways, and the rights of road users. 1700 w. Auto Jour—March 26, 1904. Serial. 1st part. No. 61899 A.

Motor Car.

The Wolseley Light Six-Horse-Power Motor Car. Illustrated detailed description. 1500 w. Engng—April 1, 1904. No. 62070 A.

Operating Costs.

Some Data on the Cost of Operating Automobiles for Commercial Purposes. Hiram Percy Maxim. Read before the Auto. Club of America. Tests of electric, gasoline, steam and gasoline-electric vehicles, giving much valuable information regarding storage battery maintenance and its cost. 4500 w. Sci Am Sup—April 23, 1904. Serial. 1st part. No. 62302.

Paraffin.

A Successful Paraffin Motor. An illustrated description of an internal combustion motor using paraffin oil as fuel and running without smoke or smell. 1500 w. Autocar—April 16, 1904. Serial. 1st part. No. 62329 A.

Petrol Cars.

The 4-Cylinder 15-20-H. P. Brooke Petrol Car. Begins an illustrated detailed description of this car, which is on exhibition at Agricultural Hall. 1700 w. Auto Jour—March 26, 1904. Serial. 1st part. No. 61898 A.

The 20-H. P. Hutton Petrol Car. An illustrated detailed description of a high-class car having many novel features. It is of English manufacture. 4200 w. Auto Jour—March 26, 1904. Serial. 1st part. No. 61897 A.

The Wilson-Pilcher Petrol Cars. Enumerates the chief special features of these cars, and considers constructional details. Ills. 4000 w. Auto Jour—April 16, 1904. Serial. 1st part. No. 62330 A.

Road Trains.

The Renard Automobile Road Trains. An illustrated detailed description. 900 w. Automobile—April 9, 1904. No. 62009.

Steam Car.

The White Steam Car. Begins an illustrated detailed description of a vehicle which can be driven 100 miles without replenishment of fuel or water. 1200 w. Autocar—April 9, 1904. Serial. 1st part. No. 62150 A.

Tires.

Anti-Skid and Puncture-Proof Bands and Envelopes for Pneumatic Tires. Illustrates and briefly describes some of the devices tested recently in France. 900 w. Sci Am Sup—April 2, 1904. No. 61861.

Tinning.

See Electrical Eng'ng. Measurement.

Turbo-Electric.

A Turbo-Electric Wagon. From the *Horseless Age.* Illustrates and describes a novel design of motor wagon propelled by means of a steam turbine and electric motors. 1400 w. Mech Engr—Feb. 20, 1904. No. 61699 A.

HEATING AND COOLING.

Exhaust Steam.

Two Suggestions for Exhaust Steam Heating. William E. Wood. Suggestions intended for engineers in charge of power houses of moderate size, who are called upon to heat certain spaces in the most economical manner. 1000 w. Eng News—April 7, 1904. No. 61994.

Car Refrigeration.

Mechanical Refrigeration of Freight Cars. Warren H. Miller. States some of the severe requirements of car refrigeration and describes the Miller system. Ills. 2200 w. Stevens Ind—April, 1904. No. 62320 D.

Cold Storage.

Cold Storage by Cold Air Circulation. Illustrated description of E. M. Upton's plant at Rochester, N. Y., where the American Linde Air Circulation system is installed. 3800 w. Ice & Refrig—April, 1904. No. 61878 C.

Combined System.

Combined Steam and Hot Water Radiation. Describes a system installed in a twelve-story office structure in Providence. 1400 w. Eng Rec—April 9, 1904. No. 62022.

Hot Water.

A Graphical Method of Proportioning Pipes for Hot-Water Heating (Graphische Methode der Rohrbestimmung für Wasserheizung). W. Scheer. An examination of the proportions of hot-water heating pipes, with complete charts applicable to any case, together with practical examples of their application. 7000 w. 2 plates. Gesundheits-Ingenieur—March 20, 1904. No. 62244 D.

HYDRAULICS.

Air Lift.

The Direct Elevation of Liquids by Compressed Air (Elévation Directe des Liquides par l'Air Comprimé). E. Lemaire. Illustrating various devices, including the air lift of Siemens, Laurend, and Pöhle, as well as the suctions systems of Jandin and Borsig, and the pressure elevator of Kestner. 2500 w. Génie Civil—March 19, 1904. No. 62212 D.

Flow.

Discharging Capacity of Culverts. Washington Parker Ireland. Reviews the theoretical explanation of the flow of water through pipes, and investigates the flow through large pipes. Ills. 2000 w. Eng Rec—April 2, 1904. No. 61805.

Hydraulic Machinery.

Hydraulic Power Appliances in the Engineering Industries. George H. Baxter. Mr. Baxter's second paper is devoted to the application of hydraulic power to the operation of wharf cranes, capstans, and auxiliary machinery. 2500 w. Engineering Magazine—May, 1904. No. 62272 B.

Pitot Tubes.

Pitot Tubes: With Experimental Determinations of the Form and Velocity of Jets. James E. Boyd and Horace Judd. Read before the Am. Assn. for the Adv. of Science. An account of experimental investigations with results. 4400 w. Eng News—March 31, 1904. No. 61848.

Pumping Engines.

Improvements in Economy of Pumping Engines. F. W. Dean. Discusses methods of superheating, and the use of superheaters as a means of promoting economy. 2500 w. Jour New Eng W. Works Assn —March, 1904. No. 62096 F.

Pumps.

Improved Pumps (Neue Pumpen). Illustrated description of the Steuer express pump, showing its arrangement for underground service with electric driving. 1800 w. Zeitschr d Ver Deutscher Ing—April 2, 1904. No. 62206 D.

Pumps and Pumping Machinery. G. A. F. Ahlberg. Considers general rules in designing pumps, different types, duty and efficiency, etc. Pro Engrs' Soc of W. Penn Jan., 1904. No. 62306 D.

Test of Centrifugal Pump. P. P. Bird. Description and illustrations of the method recently used in testing a pump for the armored cruiser "West Virginia." 1300 w. Marine Engng—April, 1904. No. 61816 C.

The Pumps at the Aussig Industrial Exposition, 1903 (Die Pumpwerke auf der Deutschen Gewerbe und Industrieausstellung in Aussig, 1903). Alexander Fieber. Illustrating especially recent German designs of high-speed pumps. 2000 w. 1 plate. Oesterr Zeitschr f Berg u Hüttenwesen—March 19, 1904. No. 62233 D.

Turbine Pumps.

High-Pressure Multi-Stage Turbine Pumps with Special Balancing Device. Illustrated description. 1500 w. Eng News —April 7, 1904. No. 61992.

INTERNAL-COMBUSTION MOTORS.

Alcohol.

See Mechanical Engineering, Automobiles.

Fire Boat.

A Petrol Motor Fire Boat. Brief illustrated description. 500 w. Auto Jour— April 2, 1904. No. 62056 A.

Gas Engines.

Gas Engine Design Constants and Formulas. Sandford A. Moss. Gives tabulated data, the result of an investigation of gas-engine properties begun by the Dept. of Mach. Design, Cornell Univ., with explanations of formulas derived. 2500 w. Am Mach—April 14, 1904. No. 62043.

Small Gas Engines v. Electric Motors. H. E. M. Kensit. Gives tabulated particulars of the cost of operating a number of small gas engines used in various trades, showing a large saving in favor of electric motors for intermittent loads. 800 w. Elec Rev, Lond—April 15, 1904. No. 62-337 A.

The Blaisdell Tandem Gas Engine. Illustrates and describes a new heavy duty tandem type recently brought out. 1200 w. Ir Age—April 14, 1904. No. 62038.

The Gas Engine for Central Station Service. Ralph D. Mershon. Read before the N. Y. Elec. Soc. Considers methods of operating, governing, etc.; also cost. 4500 w. Engr, U S A—April 1, 1904. No. 61856 C.

The Gas Engine from the Manager's Standpoint. H. W. True. Read before the New England Assn. of Gas Engrs. Discusses the fuels and their cost for gas engines, their most profitable uses, reliability, and the methods that should be pursued by gas companies to have manufactured gas used, etc. General discussion. 9000 w. Am Gas Lgt Jour—April 11, 1904. No. 62025.

The Nurnberg Gas Engine. Illustrated description of an American-built engine of foreign design. 2000 w. Power—April, 1904. No. 61825 C.

Paraffin.

See Mechanical Engineering, Automobiles.

Valves.

Valves and Valve Mechanism of Internal Combustion Engines. R. E. Phillips. Excerpt of a paper read before the Auto. Club. Remarks confined to the valves and valve mechanisms used in the Otto four-cycle type. Ills. 3700 w. Prac Engr— April 15, 1904. No. 62331 A.

MACHINE WORKS AND FOUNDRIES.

Automobile Works.

The Napier Motor Car Works. Illustrated description of the works at Acton. 1400 w. Engng—April 8, 1904. No. 62-160 A.

Castings.

Clearance Allowances in Rough Castings. Joseph Horner. Discusses methods, giving helpful suggestions. Ills. 2200 w. Am Mach—April 14, 1904. No. 62044.

Cost Keeping.

See Industrial Economy.

Cranes.

Recent Installations of Electric Cranes (Neue Ausführungen Elektrischer Krane). Richard Kann. With illustrations of methods of wiring and operating, together with numerous examples of recent designs and installations. Two articles. 5000 w. Zeitschr f Elektrotechnik—March 20, 27, 1904. No. 62263 each D.

Crank Pins.

Crankpin Bearing. C. H. Bierbaum. Remarks on the conditions and performance of a crankpin bearing with explanation. Ills. 1400 w. Engr, U S A—April 1, 1904. No. 61855 C.

Cranks

Oblique Type Crank Axles. Gives a stress diagram and explains the method of calculating graphically the stresses for the design of its proportions. 600 w. Engr, Lond—April 15, 1904. No. 62348 A.

Dies.

A Combination Cutting, Drawing and Two-Hole Perforating Die. Jack Markx. Illustrated detailed description. 800 w. Am. Mach—April 7, 1904. No. 61962.

Hardening Drop Dies. E. R. Markham. Suggestions for this work, showing that methods must vary according to the stock in the die, its size and outline, the work it must do, etc. 1100 w. Am Mach—April 7, 1904. No. 61968.

Drop Hammers.

The Ambler Drop Hammer. Illustrated description. 600 w. Am. Mach—April 14, 1904. No. 62045.

Electrical Driving.

The Adaptability of Electrical Driving. B. Longbottom. Extract from a paper read before the Manchester Assn. of Engrs. Shows what efficiencies can be expected with electrical driving, comparing the results with actual tests of mechanical distribution. 3300 w. Mech Engr—April 16, 1904. No. 62333 A.

Modern Methods of Operating Machine Tools Electrically. Abstract of a lecture by Putnam A. Bates, before the Engng. Soc. of Columbia Univ. Discusses the general problems to be considered in selecting a system, and describes a particular system which gives advantages due to its methods of variable-speed control. 2500 w. Sci Am Sup—April 16, 1904. No. 62122.

Motor-Driven Machine Tools. H. M. Phillips. Discusses points of importance in planning an electrical equipment for a shop. 5500 w. Ir Trd Rev—April 7, 1904. No. 61984.

Electrical Works.

The Crocker-Wheeler Plant at Ampere, N. J., and Its Power Distribution. Illustrated detailed description. 4000 w. Ir Trd Rev—April 7, 1904. No. 61983.

Foundry Driving.

The Driving of Machinery and Tools in the Modern Foundry (Einiges über den Antrieb von Maschinen und Werkzeugen in der Modernen Giesserei). J. Groneman. With especial reference to the introduction of electric driving and to the pneumatic operation of moulding machines. 2000 w. Stahl u Eisen—March 15, 1904. No. 62-221 D.

Gear Cutter.

A Large Spur Gear Cutter. illustrates and describes a machine for placing the teeth in spur gears up to20 feet in diameter and 54-inch width of face. 900 w. Ir Age—March 31, 1904. No. 61824.

Globe Valves.

Some Tools Used in the Manufacture of Globe Valves. J. R. Gordon. Illustrates and describes tools designed to lower the cost of manufacture. 1000 w. Mach, N. Y.—April, 1904. No. 61814 C.

Grinding.

Tool-Grinding Machines. Joseph Horner. The first of a series of articles dealing with the processes and machines employed in the work of grinding tools. Ills. 3500 w. Engng—March 25, 1904. Serial. 1st part. No. 61934 A.

Jigs.

Accurate Drill Jigs. C. L. Goodrich. An illustrated account of extremely careful work to produce jigs in which the limit of variation from specifications allowed between the centers of any two holes was 0.0001 inch. 1500 w. Ir Age—March 31, 1904. No. 61822.

Lathes.

A Backwoods Lathe. John Randol. Illustrated description, with remarks. 1000 w. Am Mach—March 31, 1904. No. 61821.

Lathe Spindle.

Lathe Spindle Design. John Randol. Illustrated description of the Sloan & Chace No. 5 lathe spindle. 1500 w. Am Mach—April 14, 1904. No. 62041.

Lifting Table.

A Lifting Table—Finishing Mower Wheels. S. A. Worcester. Illustrates and describes an application of the spring counter balance, and the operations for finishing mower wheels. 1200 w. Am Mach—April 7, 1904. No. 61965.

Machine Design.

Some Practical Points in Machine Designs. W. S. Leonard. Discusses some of the practical considerations to be kept in mind. 2800 w. Mach, N. Y.—April, 1904. No. 61813 C.

Milling.

An Indexing Milling Fixture. Jos. M. Stabel. Illustrated description of a fixture used on a sensitive drill press, its indexing mechanism being semi-automatic. 800 w. Am Mach—April 7, 1904. No. 61966.

Milling Machines.

A Slot Milling Machine. Illustrated description of an automatic machine for the slotting of nuts and other small pieces. 700 w. Ir Age—April 14, 1904. No. 62037.

A Special Cam Milling Machine. John Tangye. Illustrated description of a machine which succeeded in greatly reducing the cost of certain details of engines, and in saving much time and labor. 1200 w. Prac Engr—March 25, 1904. No. 61925 A.

Milling Machine Feeds and Speeds. Aims to demonstrate that a guide for determining the proper feed of milling cutters is found in ascertaining the thickness of the chip per tooth of the cutter. Ills. 1200 w. Am Mach—March 31, 1904. No. 61820.

Molding.

Molding a Crane Base. Joseph Horner. Illustrates and describes methods of making a casting without a complete pattern. 1300 w. Am Mach—April 7, 1904. No. 61963.

Molding a Printing Machine Frame. George Buchanan. Illustrates and describes the method of molding in one piece. 800 w. Foundry—April, 1904. No. 62086.

Pickling.

The Pickling of Castings with Acid (Das Putzen der Gussstücke mit Säurewasser). J. L. C. Eckelt. Describing a method in which the dilute acid is sprayed upon the castings by jets instead of immersion in vats. 1500 w. Stahl u Eisen—March 15, 1904. No. 62222 D.

Pipe.

The Manufacture of Welded Pipe. Victor Beutner. An illustrated article reviewing the development and fully describing the process of manufacture. General discussion. 6500 w. Pro Engrs' Soc of W. Penn—Jan., 1904. No. 62305 D.

Planing.

The Planing of Curved Surfaces. Howard A. Coombs. Illustrates and describes some of the attachments to and modifications of planing machines, to adopt them to the finishing of curved instead of plane surfaces. 1000 w. Am Mach—April 21, 1904. Serial. 1st part. No. 62169.

Punch.

A Large Sectional Punch and Die. A. F. Horton. Illustration with details of the method used in manufacturing these large dies. 2200 w. Ir Trd Rev—April 7, 1904. No. 61982.

Punching Machine.

Combined Punching Machine and Slitting Rolls. W. H. Eisenbeis. Illustrated description of a machine for the production of sheet-iron stampings for transformers. 700 w. Am Mach—March 31, 1904. No. 61819.

Screws.

British Association Small Screw Gauge Committee. A Brief review of the origin of this committee and of their final report. 2000 w. Mech Engr—April 2, 1904. No. 62062 A.

Shaper.

A New Design of Back-Geared Shaper. Illustrated description of this tool. 600 w. 2000 w. Mech Engr—April 2, 1904. No. 61834 C.

Slotting Machines.

The Use of Turret Heads on Slotting Machines. R. W. Gulick. Illustrated description of the method used in the works of the Westinghouse Co., resulting in accurate, rapid work of good finish. 700 w. Am Mach—April 7, 1904. No. 61961.

Stock Tracing.

See Industrial Economy.

Tool Works.

The R. K. Le Blond Machine Tool Company's shop. Illustrated detailed description of an interesting shop in Cincinnati, and its equipment. 2500 w. Mach, N. Y. —April, 1904. No. 61812 C.

Tuyeres.

The Area of Cupola Tuyeres (Düsenquerschnitte der Kupolöfen). H. Wedemeyer. Giving applications of working formulas, and discussing the influence of tuyere area on performance. 1800 w. Stahl u Eisen—April 1, 1904. No. 62227 D.

Wage Methods.

See Industrial Economy.

Welding.

Notes on Welding Sheet Iron (Mitteilungen aus der Praxis des Blechschweissens). A. Finke. Describing methods of constructing tubular structures of welded sheet iron, with tests showing their high resistance. 1800 w. Zeitschr d Ver Deutscher Ing—April 2, 1904. No. 62207 D.

Works.

The New Engineering Works of Messrs. Graham, Morton & Company at Hunslet, Leeds. An illustrated description of a new British plant. 2700 w. Ir & Coal Trds Rev—March 18, 1904. No. 61792 A.

MATERIALS OF CONSTRUCTION.

Aluminium.

A New English Aluminium Welding Machine. Illustrated description of the machine and process designed by Sherard Cowper-Coles. 1500 w. Sci Am—April 23, 1904. No. 62198.

The Corrosion of Aluminium and Its Prevention. William Roy Mott. A report of experimental investigations. 700 w. Elec Chem Ind—April, 1904. No. 61978 C.

Alloys.

Antifriction Alloys. John F. Buchanan. A general discussion of these alloys, and points to be observed in compounding. 3300 w. Foundry—April, 1904. No. 62-085.

Alumino-Thermics.

Alumino-Thermies, or the Production of High Temperatures by Burning Aluminum. E. Stütz. An explanation of some of Dr. Hans Goldschmidt's remarkable discoveries in the creation of high temperatures by means of aluminum, and the applications made. 4800 w. Jour Fr Inst—April, 1904. No. 62099 D.

The Production of Pure Metals Free from Carbon by the Alumino-thermic method. Hans Goldschmidt. Information on the production of pure metals by this method, and on the uses of such metals in metallurgy. 2000 w. Elec-Chem Ind —April, 1904. No. 61981 C.

"Elastic Limit."

The Use of the Term "Elastic Limit" in Metals Under Stress. W. C. Popplewell. Discusses the true meaning of the term and its limitations. The material referred to is the metals. 4500 w. Engng Rev—April, 1904. No. 62388 B.

Lubricants.

Lubricating Oils and Their Properties—How to Test Them and to Detect Adulterations. William Davis. 900 w. Power —April, 1904. No. 61832 C.

The Selection and Testing of Lubricants. A. O. Doane. Information concerning various oils, with suggestions helpful in selecting and testing. 2000 w. Power—April, 1904. No. 61831 C.

Microstructure.

The Relation of Microstructure to the Rate of Cooling. W. Campbell. A lecture to the Philadelphia Found. Assn. An illustrated study of alloys, showing that changes occur far below the freezing point which are of great importance. 2500 w. Ir Age—April 21, 1904. No. 62174.

Tool Steels.

Experiments with Rapid Cutting Steel Tools. Charles Day. Abstract report of a series of tests carried out in Manchester, Eng., giving results and calling attention to important points. Plate. 3000 w. Trans Inst of Engrs & Shipbuilders of Scotland—Feb. 23, 1904. No. 62317 D.

High Speed Steels. William Lodge. Prepared for the convention of the Nat. Metal Trds. Assn. Deals with the methods and materials necessary to produce desired results. 2800 w. Ir Age—April 7, 1904. No. 61887.

Notes on Tests of Rapid-Cuting Steel Tools. C. Pendlebury. On the tests made by a joint committee consisting of members of the sub-committee of the Manchester School of Technology. The trials were confined to lathe tools. 5000 w. Engr, Lond—April 1, 1904. No. 62076 A.

The Use of High-Speed Steels. E. R. Markham. Suggestions in regard to the use of this material. 1500 w. Am Mach—April 7, 1904. No. 61964.

MEASUREMENT.

Anemometers.

The Determination of Air Currents in Testing Anemometers (Ueber Mitwindbestimmung bei Anemometer-Prüfungen). H. Stach. An examination of the method of testing anemometers by subjecting them to known air currents; showing the importance of correcting for the motion of the air in the room. 1000 w. Glückauf—March 19, 1904. No. 62240 D.

Hardness.

The Steel Ball Test (Die Kugel-druck Prüfung). Albert Ohnstein. Describing an improved apparatus for applying the Huber modification of Brinell's test for hardness; using the depression made by a steel ball as a measure. 1000 w. Stahl u Eisen—April 1, 1904. No. 62226 D.

Humidostat.

The Control of Humidity by Means of the Humidostat. W. S. Johnson. A brief illustrated explanation of a method of controlling humidity. 1400 w. Eng News—April 21, 1904. No. 62181.

Micrometers.

Determining the Errors in Screws. Robert A. Bruce. A screw-measuring apparatus is illustrated and described, with the method of using. 1200 w. Am Mach —April 7, 1904. No. 61969.

Temperature.

The Measurement of Temperature. Robert S. Whipple. Gives a summary of the various means of measuring temperature in general use, and tests of their applications. Ills. 3000 w. Engng Times—March, 1904. No. 62385 B.

Testing.

The Equipment of an Engine Test House. R. K. Morcom. A brief account of the evolution of a plant for testing combined sets for electricity stations, and of some of the more interesting results obtained. Also discussion. 4200 w. Elec Rev, Lond—March 25, 1904. No. 61930 A.

POWER AND TRANSMISSION.

Belts.

Graphical Diagrams for Determining Belt Widths (Graphische Tabelle zur Bestimmung der Riemenbreite). Prof. Rudolf Escher. Deriving curves which enable the power transmitted by belts to be determined by inspection, for various speeds and pulley diameters. 1200 w. Schweizerische Bauzeitung—March 19, 1904. No. 62229 D.

Cableways.

Aerial Ropeway for Contractors' Work. Daniel Bellet. Gives an illustrated description of the construction of a railway in the French Pyrenees, in which an aerial ropeway was first built for transporting the necessary material. 1000 w. Trac & Trans—April, 1904. No. 62081 E.

Cableways for Open-Pit Mining. Spencer Miller. An illustrated article discussing the advantages of horizontal cableways and those of the radial type. 1800 w. Mines & Min—April, 1904. No. 61949 C.

Suspension Cableways. Andrew A. Bruch. An illustrated article explaining the use and construction of inclined and horizontal cableways. 3300 w. Mines & Min—April, 1904. No. 61946 C.

Wire-Rope Tramway at Grand Encampment, Wyoming. Illustrated description of a line sixteen miles long. 2800 w. Mines & Min—April, 1904. No. 61959 C.

Chains.

Construction of the West Point Chain. E. P. Buffet. An account of the chain stretched across the Hudson River by the American Army during the Revolutionary War, giving authentic records in regard to its manufacture. 2500 w. Am Mach—April 21, 1904. No. 62172.

Compressed Air.

Air Compressor Plant at Marshall Field Store, Chicago, Ill. Illustrated detailed description of this plant. 1700 w. Compressed Air—April, 1904. No. 62340.

Explosions in Air Compressors. E. Goffe. Read before the Mech. Engrs'. Assn. of the Witwatersrand. Describes conditions under which explosions occurred in South Africa, discussing the causes. 2400 w. Mech Engr—April 16, 1904. No. 62334 A.

Conveyors.

Mechanical Conveyors. Walter Renton Ingalls. Deals with the use of conveyors for the transportation of ore and other mineral substances. 2500 w. Eng & Min Jour—April 21, 1904. Serial. 1st part. No. 62193.

Travelling Blocks and Hoists. Illustrates and describes apparatus used with the overhead trolley conveying, stating the uses to which this form of transport may be applied and its advantages. 3500 w. Ir & Coal Trds Rev—March 11, 1904. No. 61791 A.

Elevators.

Elevators: Their Construction and Operation—Horizontal Cylinder, Hydraulic Elevators, Pushing Type. William Baxter, Jr. Explains the difference between the pulling and the pushing types of horizontal hydraulic elevators, illustrating details. 1200 w. Engr, U S A—April 15, 1904. Serial. 1st part. 62136 C.

Mechanical Plant.

The Mechanical Plant of the Minnesota State Capitol. Illustrates and describes the plant for this building in St. Paul, which is heated by the plenum system, lighted by electricity, provided with hydraulic elevators and furnished with water distribution, and extensive call-bell and telephone systems. 4500 w. Eng Rec—April 16, 1904. No. 62127.

Repairs.

Repairs in a Power Plant. William J. Kaup. The present article deals with conditions essential to be understood by the workman. Ills. 900 w. Engr, U S A—April 1, 1904. Serial. 1st part. No. 61857 C.

Ropes.

Effects of Bending Stresses on Wire Rope. J. B. Richards. How excessive bending may entirely destroy the safe working strength of a rope. 1200 w. Mines & Min—April, 1904. No. 61956 C.

Formulæ for Calculating the Size of Wire Ropes. Sheldon Smillie. Gives empirical formulæ deduced from tables published by J. A. Roebling's Sons Co., and found to give the same results as the table. 700 w. Sch of Mines Qr—Jan., 1904. No. 62309 D.

Glossary of Rope Terms. With special reference to the meanings of words used in connection with the manufacture and use of wire rope. Ills. 1500 w. Mines & Min—April, 1904. No. 61951 C.

History of Wire Rope. Brief account of the early use of rope and illustrated description of some of the modern varieties. 2300 w. Mines & Min—April, 1904. No. 61957 C.

Hoisting Ropes. George S. Whyte. Considers quality of materials, methods of manufacture, style of lay, and their influence on wearing qualities. 2400 w. Mines & Min—April, 1904. No. 61954 C.

Practical Points in the Construction and Use of Wire Rope. L. C. Moore. Considers material, tensile strength, load, sheaves, causes of wear, etc. 4300 w. Mines & Min—April, 1904. No. 61947 C.

Splicing Wire Ropes. Illustrates and describes the method recommended by the John A. Roebling's Son's Company, of Trenton, N. J. 1000 w. Mines & Min—April, 1904. No. 61952 C.

The Transmission of Power by Ropes. Edwin Kenyon. Abstract of a lecture delivered at the Blackburn Technical School. Considers cost, applications, the various systems, the construction of ropes, splicing, etc. Ills. 5300 w. Mech Engr—March 26, 1904. No. 61926 A.

The Transmission of Power by Wire Rope. W. H. Graves. Illustrated description of a system known as the single loop, a modification of belt driving, grooved wheels being used in place of pulleys, and an endless wire rope in place of a belt. 3800 w. Mines & Min—April, 1904. No. 61955 C.

Wire-Rope Calculations. A comparison of the methods of determining the proper working load for wire rope. 2500 w. Mines & Min—April, 1904. No. 61960 C.

See also Mining and Metallurgy, Mining.

Spring Motor.

The Pfeiffer Spring Motor. An explanation of the sense in which the term "spring motor" is used is given, with an illustrated description of the mechanism. 1600 w. Ir Age—April 7, 1904. No. 61886.

Worm Gears.

Worm Gear Experiences—Warnings and Examples. J. E. Johnson, Jr. Illustrates a short tooth worm gear, and gives information gained from the materials used, and the construction. 2200 w. Am Mach—April 21, 1904. No. 62170.

STEAM ENGINEERING.

Boiler Explosions.

Boiler Design and the Causes of Boiler Explosions. R. S. Hale. A study of government and insurance records, showing the controlling influence of sound design upon safety. 5000 w. Engineering Magazine—May, 1904. No. 62275 B.

Boilers.

Cleaning Steam Boiler Surfaces. R. T. Strohm. Describes methods used for cleaning shell and tubular boilers. Ills. 2500 w. Am Elect'n—April, 1904. No. 61892.

The Practical Management of Stationary Steam Boilers. R. T. Cooke. An account of the everyday management of steam boilers, with a view to maximum efficiency and a minimum production of smoke. 4000 w. Engr, Lond—April 15, 1904. No. 62346 A.

Boiler Tests.

Report of Competitive Tests Between Babcock & Wilcox and Stirling Boilers, made at Los Angeles, Cal., 1903. Full report covering every detail of the tests made of these water-tube boilers when burning oil, and giving a great amount of information. Ills. 10000 w. Jour of Elec—April, 1904. No. 62148 C.

Boiler Tubes.

Setting Boiler Tubes. Illustrates and describes various tools used and methods devised. 1000 w. Am Mach—April 21, 1904. No. 62171.

Engines.

Modern High-Speed Steam Engines. Considers the development of the high-speed engine, describing the "Willans" as representing the single-acting type, and the "Belliss" engine for the double-acting type. 2000 w. Engr, Lond—April 15, 1904. Serial. 1st part. No. 62342 A.

The Economy of Reciprocating Engines at Light Loads as Compared with that of Steam Turbines. J. A. Seymour. Gives results of tests made, with explanatory notes. 1800 w. Power—April, 1904. No. 61833 C.

The Internal Surfaces of Steam Engines. W. H. Booth. Discusses points in designing with a view to diminishing the internal surfaces to a minimum, and the question of superheated steam. 2500 w. Engr, U S A—April 15, 1904. No. 62-135 C.

150-Horse-Power Compound Electric Light Engines for the Royal Navy. Illustrated description of the engines of two electric generating sets to be installed on the Téméraire, a training vessel for lads to become engine-room artificers. This vessel will be the central generating station, supplying power to two floating factories and for lighting. 1300 w. Engng—April 15, 1904. No. 62352 A.

"Entropy."

A Criticism of Mr. James Swinburne's "Entropy." Robert H. Smith. Criticizes recent work published in two particulars—the clearness of the theories, and the accuracy of mathematical developments. 2700 w. Elec Rev, Lond—April 15, 1904. No. 62336 A.

Entropy. John Perry. A criticism of the work by James Swinburne, recently published. 3500 w. Nature—April 14, 1904. No. 62355 A.

Exhaust Steam.

Utilizing the Exhaust of Intermittently-Working Engines. J. Walter Pearse. Illustrates and describes Prof. Rateau's system of steam accumulator regenerator and low-pressure steam turbine for utilizing waste steam. 4000 w. Engng Rev—March, 1904. No. 62390 B.

Indicators.

The Direct Production of Time Diagrams from Ordinary Indicators (Verfahren zur unmittelbaren Entnahme von Zeitdiagrammen mit Gewohnlichen Indikatoren). W. Schüle. Describing the making of indicator diagrams by giving the drum a uniform rotary motion independently of the motion of the engine. Two articles. 6000 w. Zeitschr d Ver Deutscher Ing—March 26, April 2, 1904. No. 62202 each D.

Liquid Fuel.

Liquid Fuel Burners. J. S. V. Bickford. The present article considers the class of vapor burners designed for the use of petroleum lamp oil, discussing the production of the vapor. Ills. 4400 w. Engng—April 15, 1904. Serial. 1st part. No. 62351 A.

Locomotive Boilers.

Designing of Locomotive Boilers. Roger Atkinson. Considers the general principles and discusses details. 1500 w. Loc Engng—April, 1904. Serial. 1st part. No. 61879 C.

Lubrication.

The Crandall Mechanical Lubricating System. Illustrated description. 1000 w. Ir Age—April 14, 1904. No. 62040.

Piping.

Something About Piping. W. H. Wakeman. Suggestions concerning the location and operation of pipes in steam plants. 1400 w. Power—April, 1904. No. 61-829 C.

Regulation.

Automatic Governing of Marine Engines. H. M. Wilson. Read before the N. E. Coast Inst. of Engrs. & Shipb'ldrs. States facts showing the need of marine reciprocating engines having a good automatic governor, illustrating and describing the principal governors. 4800 w. Mech Engr—April 16, 1904. No. 62332 A.

Rotary Engines.

Antiquity of the Rotary Engine. E. P. Buffet. Illustrates two models of early dates, embodying this principle. One about 1796, the other much earlier. 1500 w. Power—April, 1904. No. 61828 C.

Steam Pumps.

See Mechanical Engineering, Hydraulics.

Superheating.

Superheated Steam. F. J. Rowan. Continued discussion and correspondence in connection with this paper. 4500 w. Trans Inst of Engrs & Shipbuilders in Scotland—Feb. 23, 1904. No. 62314 D.

The Conveying of Superheated Steam (Die Fortleitung des Ueberhitzten Wasserdampfes). Dr. Otto Berner. A discussion of the losses in carrying superheated steam through pipes. Serial. Part I. 4000 w. Zeitschr d Ver Deutscher Ing—April 2, 1904. No. 62204 D.

Turbines.

Reciprocating Sets vs. Turbo-Generators. I. William Chubb. Reports trials made, as a contribution to the discussion on the relative advantages in connection with power house-plants. 1800 w. Power—April, 1904. No. 61830 C.

Steam Turbines (Ueber Dampfturbinen). Dr. A. Riedler. A general review of the development of the steam turbine, with especial reference to the Riedler-Stumpf turbine. Two articles. 6000 w. Zeitschr d Oesterr Ing u Arch Ver—March 25, April 1, 1904. No. 62209 each D.

Steam Turbines v. Reciprocating Engines. J. H. Barker. Considers the advantages of turbines as compared with reciprocating engines, and concludes that reciprocating engines will be in demand for powers to 1,000 h. p., and above such a power the trend of opinion is toward turbines. 4500 w. Engng Rev—March, 1904. No. 62389 B.

The De Laval Steam Turbine. Charles Garrison. An illustrated detailed description of the principal parts of the De Laval steam turbine, stating its advantages over the reciprocating engine, its economical operation, types, uses, &c. 5800 w. Tech Qr—March, 1904. No. 62356 E.

The Steam Turbine and Its Field in Marine Work. Lieut. H. C. Dinger. Gives a brief résumé of the advantages of the turbine, in distinction from the reciprocating engine, and the types of craft that the turbine would be suitable for; also the types of turbines proposed for marine work. 2000 w. Sci Am—April 9, 1904. No. 62006.

The Steam Turbine as an Exhaust-Steam Utilizer. From *Le Génie Civil.* Describes an installation in the mines at Bruay where a combination of accumulator and turbine is used as brought out by Prof. Rateau. 2000 w. Eng Rec—April 23, 1904. No. 62373.

The Steam Turbine in Power House Extensions. Illustrated description of an interesting application of the steam turbine at the station of the Rockland Light and Power Company, at Orangeburg, N. Y. 1800 w. Am Elect'n—April, 1904. No. 61890.

The Yale & Towne Mfg. Company's

Power Plant. An illustrated description of the first plant in which the use of the steam turbine was commercially attempted outside of the works of the builders of the turbine. 1800 w. Ir Age—April 21, 1904. No. 62173.

See also Marine and Naval Engineering.

Valves.

Reversing Valves for Regenerative Furnaces. A. D. Williams, Jr. Shows the losses due to a poor valve, and comments on some good valves. 2000 w. Ir Age—April 7, 1904. No. 61889.

Setting the Valves of the Brown Engine. Illustrated directions. 2000 w. Power—April, 1904. No. 61826 C.

MISCELLANY.

Aeronautics.

The Beedle Airship. Illustrated description of the novel features. The frame is arranged in the form of a triangle, within which is placed the motor, and the aeronaut's basket. 700 w. Sci Am—April 16, 1904. No. 62120.

Gunsight.

The "Grubb" Sight. Description, illustrations, and explanation of its application. 2800 w. Jour U S Art—March, 1904. No. 62304 D.

Laboratories.

The National Physical Laboratory. A summary of the work done and of the instruments and machines thus far added to the equipment, with information concerning the needs, etc. 4800 w. Engng—March 25, 1904. No. 61933 A.

Pulverizers.

The Action of Ball Mills (Der Arbeitsvorgang in Kugelmühten). Hermann Fischer. An examination of the action of pulverizers in which steel balls are used in a revolving cylinder. Photographs at various speeds are given. 2500 w. Zeitschr d Ver Deutscher Ing—March 26, 1904. No. 62201 D.

MINING AND METALLURGY

COAL AND COKE.

Briquettes.

Briquetting Fuel Material. George E. Walsh. Considers the waste material which contains sufficient burning properties to utilize as fuel, the efficiency and cost of briquetting, and related subjects. 3500 w. Power—April, 1904. No. 61827 C.

Recent Advances in the Utilization of Peat and Lignite. H. H. Wotherspoon, Jr. Abstract of a paper read before the N. Y. Acad. of Sci. concerning the manufacture and cost of briquettes in Europe. Ills. 600 w. Eng & Min Jour—April 7, 1904. No. 61988.

Central Asia.

Coal and Petroleum in Central Asia. E. D. Levat. Translated from paper entitled "Richesses Minérales des Possessions Russes en Asia Centrale." Concerning the deposits, their location, geology, etc. 2300 w. Eng & Min Jour—April 7, 1904. No. 61990.

Coal-Field.

A Missouri Coal-Field. William Griffith. Describes a bituminous field near the St. Louis, Kansas & Colorado railroad. Ills. 600 w. Eng & Min Jour—April 7, 1904. No. 61989.

Coking.

The Coking of Lignite at Zsiltale in Hungary (Die Verkokung der Braunkohle im Zsiltale in Ungarn). A. Semlitsch. Describing the successful production of blast-furnace coke by coking compressed briquettes of lignite. Analyses of the lignites given and details of the oven and furnaces. Two articles, 1 plate. 4000 w. Oesterr Zeitschr f Berg u Hüttenwesen—March 12, 19, 1904. No. 62231 each D.

The Méguin Coke Oven Charger. O. Simmersbach, in *Stahl und Eisen*. Illustrates and describes the destinctive features; the chief is the stamping mechanism, by means of which the charge is compressed before introducing into the ovens. 900 w. Col Guard—April 8, 1904. No. 62158 A.

Crow's Nest.

Notes on Some Special Features of Coal Mining in the Crow's Nest. James McEvoy. Read at meeting of the Canadian Min. Inst. Describes the geology of this region and the physical and chemical properties of the coal. 1800 w. Can Min Rev—March 31, 1904. No. 61810 B.

Fifeshire.

The Fifeshire Coalfields. Extract from the *Dunfermline Express*. Description of the collieries working the Dunfermline Burgh mineral royalties. 2000 w. Col Guard—April 8, 1904. No. 62159 A.

Pocahontas.

The Coals and Coal Mining Methods of the Pocahontas Field. George L. Fowler.

The first article is devoted to the geological and operative features of the district, with numerous illustrations. Serial, Part I. 4000 w. Engineering Magazine—May, 1904. No. 62274 B.

COPPER.

Concentration.

Concentrating Methods at La Cananea, Sonora, Mexico. D. Cole. Describes the plant and the flow of material in a single section of concentrator. Copper. Ills. 1200 w. Min Rept—April 14, 1904. No. 62139.

GOLD AND SILVER.

Boundary District.

Gold and Silver Mines near Greenwood. E. Jacobs. Information concerning the mineral claims of this district, especially the Providence, Elkhorn and E. P. U. mines. Ills. 2800 B C. Min Rec—April, 1904. No. 62014 B.

Canvas Tables.

Canvas Tables. H. P. Stow. From the Trans. Cal. Min. Assn. Describes a canvas table of unusual design and explains its advantages. 1800 w. Min & Sci Pr—March 26, 1904. Serial. 1st part. No. 61884.

Chlorination.

Fuel Oil in Roasting for Chlorination. E. C. Voorhies. From Trans. Cal. Min. Assn. Briefly describes the furnace used, and its operation, detailed statement of the amount of oil and coal used. 1000 w. Min & Sci Pr—March 26, 1904. No. 61885.

Concentration.

Wet Concentration of Ores by the Sherman System. Frederick Wooster Sherman. An illustrated description of this system, with the results obtained. 3000 w. Min & Sci Pr—March 26, 1904. No. 61883.

Cyanide.

Estimation of Available Cyanide. J. E. Clennell. Considers some of the factors upon which the efficiency of a cyanide solution depends, and gives a method of comparing the solvent activity of solutions. 1200 w. Eng & Min Jour—March 31, 1904. No. 61838.

The Determination of Constants in Working Cyanide Solutions. Gerard W. Williams. Gives the results the author obtained from a series of experiments instituted with a view to determining the dissociation and hence the gold-solvent power of the double cyanide of zinc and potassium in the presence of the factors usually found in a working cyanide solution. 8500 w. Jour of Chem, Met & Min Soc of S Africa—Feb., 1904. No. 62152 E.

Dredging.

The Gold Dredging Industry. F. W. Griffin. Trans. Col. Min. Inst. Information concerning dredges and dredging, and the rapid development of this business. 3000 w. Min & Sci Pr—April 16, 1904. No. 62382.

Filter Pressing.

Filter-Pressing in Western Australia. W. A. Prichard. Illustrates and describes the filter-press treatment of slimes at Kalgoorlie. 2000 w. Eng & Min Jour—April 14, 1904. No. 62113.

Korea.

Gold Mining in Korea. H. C. Perkins. Information concerning the deposits and methods of mining. 1000 w. Eng & Min Jour—April 7, 1904. No. 61986.

Machinery.

Choice of Gold Mining Machinery. Donald Clark. Suggestions for the selection of suitable machinery, and related subjects. 2500 w. Aust Min Stand—Feb. 18, 1904. Serial. 1st part. No. 61924 B.

Mexico.

The Guanajuato Mining District. Robert T. Hill. Map, illustrations, history and description of recent progress. 2500 w. Eng & Min Jour—April 14, 1904. Serial. 1st part. No. 62112.

The Ocampo District, Mexico. Arthur K. Townsend. An account of this silver-bearing region, the methods of mining, etc. 2500 w. Eng & Min Jour—March 31, 1904. No. 61839.

Milling Practice.

Notes on Mill Construction, Milling and Amalgamation. I. Roskellev. Calls attention to some alterations that would improve the mills of the Witwatersrand, and points in mill construction, describing milling practice. 7400 w. Jour of Chem, Met, & Min Soc of S Africa—Feb., 1904. No. 62151 E.

Placer Mining.

The Pump in Placer Mining. J. A. Yeatman. An illustrated description of a placer mine using artificial pressure head produced by step pressure pumps. 1200 w. Min & Sci Pr—April 2, 1904. No. 62033.

Roasting.

The Merton Furnace (Der Merton-ofen). Gustav Kroupa. Describing the Merton roasting furnace as used by the Great Boulder Co. at Kalgoorlie. The ore is kept moving continually through the furnace by the action of revolving arms. 1000 w. Oesterr Zeitschr f Berg u Hüttenwesen—April 9, 1904. No. 62238 D.

Russia.

Free Gold in Basic Igneous Rocks in Southeastern Russia. W. H. Weed. Describes the occurrence and discusses the origin of the gold and silver. 1300 w. Eng & Min Jour—March 31, 1904. No. 61842.

Screens.

Capacity of Revolving Screens. J. M. Callow. Gives results of experiments showing the comparative capacities of different size screen cloth, and the different rates of travel of ore for different slopes. 600 w. Min Rept—April 7, 1904. No. 62015.

Stamp Mills.

A High-Speed Gravitation Stamp Mill. Edgar Smart. Illustrates and describes new type recently tried in Johannesburg. The results are a marked advance in existing practice. 3800 w. Page's Mag—March, 1904. No. 62386 B.

Transylvania.

The Gold Mines of Nagyag (Der Goldbergbau Nagyág). Julius Steinhausz. A general account of the important mines at Nagyag, in Transylvania, with topographical map and profile. 2500 w. 1 plate. Oesterr Zeitschr f Berg u Hüttenwesen—April 2, 1904. No. 62235 D.

IRON AND STEEL.

Blast Furnaces.

Modern Blast-Furnace Construction (Gesichtspunkte beim Bau Modernen Hochöfen). E. Lamoureux. A review of modern furnace construction, comparing European and American practice. 3000 w. Stahl u Eisen—April 1, 1904. No. 62224 D.

Stock Distribution and Its Relation to the Life of a Blast-Furnace Lining. David Baker. A discussion of difficulties due to mechanical handling and the efforts made to remedy the troubles, with partial success. Ills. 2000 w. Ir & Coal Trds Rev—April 8, 1904. No. 62166 A.

Cranes.

Furnace Charging Cranes. Illustrates and describes modern types of cranes for this purpose. 2500 w. Ir & Coal Trds Rev—April 1, 1904. No. 62083 A.

Electric Driving.

The Cascade Connection of Motors in Rolling Mills. E. Danielson, in the *Elektrotechnische Zeitschrift.* Gives a description of one of the three-speed motors. Ills. 1200 w. Elec Engr, Lond—April 1, 1904. No. 62063 A.

Mesabi District.

Mining Methods in the Mesabi Iron District, Minnesota. Kirby Thomas. An illustrated description of mining principally by the open-cut method with steam shovels. 2500 w. Min & Sci Pr—April 16, 1904. No. 62381.

Open Hearth.

Gas Losses in Open-Hearth Furnaces (Die Gasverlustee der Siemensöfen). Fr. Schraml. An examination of the various sources of leakage and losses of fuel gas in supplying open-hearth furnaces, with suggestions for improvements in the valves. 1800 w. Stahl u Eisen—March 15, 1904. No. 62218 D.

The New Open Hearth Steel Works of the French Navy at Guérigny (Das Neue Martinstahlwerk der Französischen Marine in Guerigny). Illustrating and describing the new works for the manufacture of armor-plate steel, with especial reference to the furnaces. 1500 w. Stahl u Eisen—March 15, 1904. No. 62217 D.

Ore.

The Iron Ore Deposits of Galicia (Eisenerzvorkommen in Galicien). H. Teichgrüber. A brief description of the deposits in the vicinity of Vigo and Corunna, Spain. 1800 w. Stahl u Eisen—March 15, 1904. No. 62216 D.

Piping.

The Development of the Riemer Process for Preventing Piping of Steel Ingots (Weitere Entwickelung des Reimerschen Verfahren zur Herstellung Dichter Stahlblöcke). Giving photographs of sections of ingots showing the great reduction in piping and porosity by use of the new process. 1000 w. Stahl u Eisen—April 1, 1904. No. 62225 D.

Rod Mills.

The Construction and Operation of Wire Rod Rolling Mills (Ueber Bau und Betrieb von Drahtwalzwerken). J. Hübers. Describing various arrangements of rolls for continuous mills, including one in which they are placed side by side, the rod passing around in a spiral. 2000 w. Stahl u Eisen—March 15, 1904. No. 62220 D.

The New Wire-Rod Rolling Mill at Differdingen (Die Neue Drahtwalzwerksanlage in Differdingen). K. Gruber. Describing a plant in which the rolls are driven by a double gas engine, operating with blast-furnace gas. 2000 w. 1 plate. Stahl u Eisen—April 1, 1904. No. 62223 D.

Separators.

Swedish Ore Separators (Schwedische Erzscheideapparate). Dr. Leo. Giving a series of brief notices of all the magnetic iron-ore separators which have been used in Sweden. Two articles, 4500 w. Oesterr Zeitschr f Berg u Hüttenwesen—March 25, April 2, 1904. No. 62234 each D.

The Forsgren Magnetic Separator (Neues Separatorsystem zur Aureicherung Von Magneteisenerzen des Ingénieurs Emil Forsgren). Dr. Leo. Describing the work of magnetic concentration of magnetite ores at Falun, Sweden. 2000 w. Oesterr Zeitschr f Berg u Hüttenwesen—March 12, 1904. No. 62232 D.

Steel Process.

The Production of Steel Without the Use of Scrap or Ore (Stahlerzeugung ohne Verwendung von Alteisen und Erz). Oskar Goldstein. Describing a combined converter and open-hearth process used in Mexico. 1000 w. Stahl u Eisen—March 15, 1904. No. 62219 D.

Valuation.

The Valuation of Iron Ores (Zur Frage des Eisenerzbewertung). Oskar Simmersbach. An examination of the method of valuing iron ores according to chemical composition, taking into account the degree of fusibility and ease of reduction, together with the process for which they are intended. 3000 w. Glückauf—March 19, 1904. No. 62239 D.

The Calculation of the Value of the Raw Material in Pig Iron Making. A. P. Gaines. Describes the method adopted by the writer for determining the relative value. 2500 w. Ir Age—April 14, 1904. No. 62039.

MINING.

British Columbia.

The Atlin District. W. Wallace Grime. Information concerning the mining laws, the methods, and the development. 1100 w. Eng & Min Jour—March 31, 1904. No. 61843.

Cableways.

See Mechanical Engineering, Power and Transmission.

Converters.

Converter Accessories. C. H. Glasser. An illustrated article describing the machinery equipment of a converter plant. 2300 w. Eng & Min Jour—March 31, 1904. No. 61841.

Electric Plant.

Electric Installation at the Noel-Sart-Culpart Collieries, Belgium. Illustrates and describes a plant of sufficient capacity to drive a hoisting engine, an underground pump, feed incandescent lamps for lighting the mine, drive an electric fan and the coal briquette factory. 2200 w. Ir & Coal Trds Rev—April 8, 1904. No. 62165 A.

The Electric Power and Transmission Plant at the Courl Mines (Die Elektrischen Kraftübertragungs Anlagen der Zeche Courl). H. Schulte. An account of a complete electric power installation in the Dortmund district; about 700 h. p. being used for hoisting, pumping, ventilation, and other work. 3000 w. 2 plates. Glückauf—April 9, 1904. No. 62243 D.

Fires.

The Handling of Underground Fires with Milk of Lime (Behandlung von Grubenfeuren mit Kalkmilch). Wolfgang Kummer. Describing a method of extinguishing fires behind masonry walls or closed workings by the injection of milk of lime under high pressure. 1500 w. Oesterr Zeitschr f Berg u Hüttenwesen—April 9, 1904. No. 62236 D.

Guides.

Some Varieties of Wood Battery Guides. W. J. Sharwood. Brief illustrated descriptions of forms used, and information concerning them. 1200 w. Min & Sci Pr—April 9, 1904. No. 62143.

Great Basin.

Geology and Economics from the Wasatch to the Sierra Nevada. A. Lakes. Illustrated description of this region and the substances of economic value found. In the plain region, salt, borax, soda and nitre are mined. The hills and volcanic rocks contain the precious metals. 2300 w. Min Rept—April 21, 1904. No. 62363.

Haulage.

The Development of the Electric Mining Locomotive. Frank C. Perkins. Illustrated detailed description of patents for mining cars and locomotives and systems of transportation and haulage by electricity in mines. 1200 w. Sci Am Sup—April 23, 1904. Serial. 1st part. No. 62300.

Wire Rope Haulage Problem. George S. Whyte. Explains method of calculating for the application of the Gunckel endless rope system of haulage. Ills. 1200 w. Mines & Min—April, 1904. No. 61948 C.

Wire-Rope Slope Haulage. An illustrated description of an arrangement for hauling on a slope under difficult conditions, with a record of the life of wire ropes. 1200 w. Mines & Min—April, 1904. No. 61950 C.

Wire Rope Tramways. J. H. Janeway, Jr. Illustrates and describes different styles of tramways, the methods of construction and circumstances suited to tramway transportation. 5200 w. Mines & Min—April, 1904. No. 61953 C.

Hoists.

Recent German High Power Electric Mining Hoists. Frank C. Perkins. Illustration and description of a direct-current mining hoist and a motor generator with a 40-ton flywheel for operation and connection with the same installed at Merklinde, I. W., Germany. 1300 w. Min Rept—April 21, 1904. No. 62364.

Some Mine Head Frames and Hoists. Walter W. Bradley. Illustrated descriptions of examples noted by the writer. 1400 w. Min & Sci Pr—April 16, 1904. No. 62383.

Test of Steam Consumption of the Electric Hoisting Machine at the Preussen Mine (Versuche zur Bestimmung des Dampfverbrauches an der Elektrischen

Fördermaschine der Zeche Preussen II.). H. Schulte. Giving diagrams showing result of tests including efficiency of engine and dynamo. 1800 w. Glückauf—March 26, 1904. No. 62242 D.

Mine Models. E. S. Sheffield, Jr. Discusses methods that have been tried to quickly and clearly illustrate underground conditions, and describes the satisfactory model devised and used at the Treadwell mine, Alaska. 700 w. Cal Jour of Tech —April, 1904. No. 61973 C.

New Zealand.

Mining in New Zealand: Past and Present. Henry A. Gordon. Abstract of presidential address delivered at meeting of the Australasian Inst. of Min. Engrs. 5500 w. N Z Mines Rec—Feb. 16, 1904. No. 62053 B.

Pumping.

Bore-Holes for Pumping Purposes. Edward S. Wight. Read before the N. of England Inst. of Min. Engrs. Describes a method by which a bore-hole can be used for pumping purposes, not as an engineering feat, but to show that mine water may be delivered direct to the surface. 1500 w. Min Rept—April 21, 1904. No. 62365.

Queensland.

Wolfram and Molybdenite Mining. From the report of Walter E. Cameron. Gives history, statistics, geology and report of demands for those minerals, describing the Lappa Lappa lodes and the Tinaroo lodes. 4000 w. Queens Gov Min Jour—Feb. 15, 1904. No. 61896 B.

Ropes.

Notes on Mine Ropes. Charles W. Comstock. Considers the various materials of which ropes are made, their endurance under tests and use, forms of strand and methods of construction. 8000 w. Mines & Min—April, 1904. No. 61958 C.

See Mechanical Engineering, Power and Transmission.

Shafts.

A Concrete Lined Shaft. Describes in detail the work of lining the Grassy Island shaft of the D. & H. Co., near Olyphant, Penn. 1200 w. Eng & Min Jour—April 21, 1904. No. 62194.

Supports.

The Use of Iron Supports for Underground Workings (Ausbau von Abbaubetrieben mit Eeisernen Stempeln). H. Middendorf. An examination of the use of iron pipe for supporting mine workings in place of the usual timbering. 2000 w. Glückauf—March 26, 1904. No. 62241 D.

Timbering.

The Most Rational Method of Timbering Inclined Workings (Welche Abbaumethode ist für Steile Gänge die Rationellste). Franz Mládek. A comparison between the advantages of vertical posts and inclined struts in timbering sloping mine workings. 1200 w. Oesterr Zeitschr f Berg u Hüttenwesen—April 9, 1904. No. 62237 D.

MISCELLANY.

Aluminium.

Aluminium: A New Process of M. Gustave Gin. P. McN. Bennie. Concerning an aluminium process recently patented. 1500 w. Elec Chem Ind—April, 1904. No. 61979 C.

Bauxite.

Bauxite in Arkansas. W. F. B. Berger. Illustrates and describes the deposits, with information concerning the uses of this mineral. 1200 w. Eng & Min Jour—April 14, 1904. No. 62114.

Laboratories.

The Equipment of Mining Laboratories. Henry S. Munroe. Discusses the equipment of laboratories at schools of engineering for mining instruction. 2500 w. Eng & Min Jour—April 7, 1904. No. 61987.

RAILWAY ENGINEERING

CONDUCTING TRANSPORTATION.

Accidents.

Truth is Better Than Comfortable Error. Editorial discussion of railway accidents, and the comparison between America and England as made by Mr. Slason Thompson. 1800 w. Loc Engng—April, 1904. No. 61881 C.

Experiments.

Train Experiments on the London and North-Western Railway. Gives report of trial trips made with a new type of engine, the Precursor, No. 513, for heavy traffic. Diagrams. 500 w. Engr, Lond—April 15, 1904. No. 62347 A.

Stopping.

Stopping with Engine Reversed and Air Brakes Applied vs. Stopping with Air Brakes Alone. Editorial discussion of the best practice, favoring the latter method. 1200 w. Loc Engng—April, 1904. No. 61880 C.

Train Orders.

Is the "19" Form of Train-Order Unsafe? H. W. Forman. A discussion of train orders, and collisions and accidents due to their misinterpretation. 2500 w. R R Eng—April 8, 1904. No. 62000.

Trans-Siberian.

Military Aspects of the Trans-Siberian Railway. Illustrations and discussion of the value of this road in the present war with Japan. 1800 w. Sci Am—April 16, 1904. No. 62118.

MOTIVE POWER AND EQUIPMENT.

Brakes.

Some Hints on Care of the Automatic Slack Adjuster. An illustrated explanation of important points in the proper management of the adjuster. 600 w. Loc Engng—April, 1904. No. 61882 C.

The Corrington Air Brake. Illustrated description of a system combining automatic and straight air apparatus in such a way as to maintain each at all times independent of the other. 1800 w. Am Engr & R R Jour—April, 1904. No. 61-837 C.

The Siemens System of Electrically Controlled Compressed Air Brakes. Abstract from *Glasers Annalen für Gewerbs und Bauwesen.* A discussion of general considerations, with an illustrated description of the Siemens system and information concerning it. 5800 w. Bul Int Ry Cong—March, 1904. No. 61796 E.

Cars.

New "High-Capacity" Wagons on the Great Central Railway. Illustrated description of 30-ton all steel bogie and cars. 2000 w. Ir & Coal Trds Rev—April 1, 1904. No. 62082 A.

New Rolling Stock for the Rhodesia Railways. Illustrates and describes special cars designed for the use of several of the officers of the line, providing comfortable accommodation for day and night. 1000 w. Engr, Lond—April 1, 1904. No. 62077 A.

Self-Emptying Coal Wagons. Illustrates and describes cars provided with doors of special design in the floors. 600 w. Engr, Lond—April 1, 1904. No. 62-078 A.

Steel in Car Construction. C. A. Seley. Suggestions for the use of steel in the box cars and coal cars, with report of cars that have been in use. General discussion. 9500 w. Pro W Ry Club—March 15, 1904. No. 62100 C.

The Construction of Steel Cars. Abstracts of three papers recently read before the Inst. of Civ. Engrs., England. 2000 w. Sci Am Sup—April 2, 1904. No. 61862.

The Lawson Improved Dumping Car. Illustrated description of a type of car used for trestle filling, ballast handling, general construction work, &c. 700 w. Am Engr & R R Jour—April, 1904. No. 61835 C.

Inspection.

Safety Appliances. George Groobey. Extracts from a paper read before the New England R. R. Club. On the number and kind of defects found by the inspectors of safety appliances. 2000 w. R R Gaz—April 1, 1904. No. 61849.

Locomotives.

American Locomotive Building (Der Amerikanische Lokomotivbau). H. Fuchs. Report of a tour of research in the United States, with illustrations and tabulated data of American methods of design and construction. Serial. Part I. 5000 w. Zeitschr d Ver Deutscher Ing—March 19, 1904. No. 62200 D.

Consolidation (2-8-0) Locomotive for the Delaware & Hudson. Illustrated detailed description of a wide fire-box engine designed for burning fine anthracite coal. 400 w. R R Gaz—April 8, 1904. No. 62001.

Economical Locomotives. Illustrations and description of a locomotive of novel design, recently tested in Italy, which shows some excellent results in coal economy, as given by Charles R. King in the *Railway Engineer.* 2000 w. Ry & Engng Rev—April 16, 1904. No. 62147.

Four-Cylinder Balanced Compound Locomotives: Atchison, Topeka & Santa Fe Ry. Illustrated detailed description of these new engines, with editorial. 6000 w. Eng News—March 31, 1904. No. 61844.

Heavy Tank Engines with Three Cylinders, Berlin Metropolitan Railway. Illustration, with description of powerful engines for suburban traffic. 800 w. Engr, Lond—April 15, 1904. No. 62344 A.

High-Speed Passenger Locomotives (Lokomotiven zur Beförderung mit Grosser Fahrgeschwindigkeit). W. Wolters. Illustrated descriptions of the successful designs in the recent competitions in Germany. 3500 w. 6 plates. Glasers Annalen —April 1, 1904. No. 62210 D.

Locomotive Frames. A discussion with lengthy introduction by Mr. Vauclain. Ills. 8000 w. N Y R R Club—March 18, 1904. No. 62102.

Michigan Central Pacific Type Locomotive. Illustration and descriptive specifications of six-wheel connected engines for heavy passenger traffic. 800 w. Ry & Engng Rev—April 16, 1904. No. 62146.

Repairs.

Locomotive Repair Records. Describes a new system which is about to be tried on one of the large railroads. A rational system in which engine ton miles is the measure of work done. 3700 w. Am Engr & R R Jour—April, 1904. No. 61836 C.

Smoke-Boxes.

Smoke-Box Action. R. Weatherburn. Discusses the essentials of efficient smoke-box action, and prevailing practice. 3800 w. Engr, Lond—April 15, 1904. No. 62349 A.

Wear.

On the Wear of Tires of Locomotive Driving Wheels and on the Creeping of the Left Hand Rail of Tracks. O. Busse. An account of investigations made on the Danish State Railways. Diagrams. 3800 w. Bul Int Ry Cong—March, 1904. No. 61793 E.

NEW PROJECTS.

Greece.

The Transhellenic Railway (Le Chemin de Fer Transhellénique). A discussion of the proposed railway connecting central Europe with the Piræus, and giving a closer connection with Port Said than the present route via Brindisi; with maps. 2000 w. Génie Civil—March 26, 1904. No. 62214 D.

Peru.

Railway Construction in Peru. Copy of an important project submitted to Congress. 1000 w. U S Cons Repts—April, 1904. No. 62091 D.

Reconnoissance.

Railway Location in the Florida Everglades. William J. Krome. An illustrated article describing an exploration survey through this territory. 1800 w. Eng Rec—April 2, 1904. Serial. 1st part. No. 61807.

Syria.

Railways in Syria. Information concerning railways building and recently completed. 1200 w. U S Cons Repts—April, 1904. No. 62092 D.

PERMANENT WAY AND BUILDINGS.

Construction.

General Rules for Construction Work Illinois Central Railroad. A review of the recently prepared rules on a road which is kept in a condition of high efficiency. 3000 w. Eng Rec—April 23, 1904. No. 62375.

Revised Regulations for Railway Construction in China. Translation of regulations in general. 3000 w. U S Cons Repts—April, 1904. No. 62090 D.

The Southern Missouri Railway. Charles A. Sheppard. An illustrated detailed description of an important piece of railroad construction. 2300 w. Eng Rec—April 16, 1904. No. 62128.

Curves.

Cornu's Spiral as a Transition Curve. D. N. Lehmer. A mathematical demonstration of the application of Cornu's spiral to railroad work. 3500 w. Cal Jour of Tech—April, 1904. No. 61971 C.

Engadine.

The Highest Railway in Europe. Enrico Bignami. Illustrates and describes interesting features of the Albula railway in Switzerland, which reaches an altitude of 5,980 feet. 2000 w. Cassier's Mag—April, 1904. No. 62107 B.

Improvements.

Revision of Grades and Double-Tracking on the Richmond, Fredericksburg & Potomac. Profile showing changes in alinement, with description of other improvements. 1200 w. R R Gaz—April 1, 1904. No. 61851.

Interlocking.

All-Electric Interlocking at Park Junction. Illustrated detailed description of a plant at Philadelphia in which all the functions are worked by electric power. 1200 w. R R Gaz—April 22, 1904. No. 62195.

Electric Interlocking at the New Central Station in Antwerp. L. Weissenbruch. Describes the signal practice on the Belgian State Railway, explaining why the Siemens system was selected for Antwerp, and giving an illustrated description. 7000 w. Ry Age—April 22, 1904. Serial. 1st part. No. 62366.

Schenectady.

The Schenectady Improvements of the New York Central. Plan, sketch map, and description of changes made to avoid high grades and crossings at street level. 1700 w. R R Gaz—April 15, 1904. No. 62117.

Shops.

London and North-Western Carriage Works, Wolverton. Briefly reviews the history of Wolverton since the first locomotive works was established, and gives an illustrated detailed description of the modern works, which cover 80 acres. 2200 w. Engng—April 1, 1904. No. 62069 A.

New Shops of the Terminal Railroad Association of St. Louis at East St. Louis, Ill. Illustrated detailed description of this new plant and its equipment. 1600 w. Ry Mas Mech—April, 1004. Serial. 1st part. No. 61854.

The Wilmington Shops of the Pennsylvania. An illustrated detailed description of this plant which shows advantageous features of equipment and arrangement. 5500 w. Ry Age—April 8, 1904. No. 62036.

Signals.

Block Signals. A. M. Schoyer. Considers the questions of color for night signals, railways controlled entirely by signals, and one arm signals for blocking two or three blocks. 5000 w. Pro Ry Club of Pittsburg—Feb., 1904. No. 62103 C.

Terminals.

The Arrangement and Operation of Railway Terminals (Ueber Anlage und Betrieb der Verschubbanhöfe). H. Pallasmann. An examination of the various arrangements of tracks and yards for the shifting of cars and making up of trains at railway terminals. 7000 w. 2 plates. Oesterr Wochenschr f d Oeffent Baudienst—March 19, 1904. No. 62246 D.

Underground Brooklyn Terminal of the Long Island Railroad. Plans and description of the terminal at Flatbush and Atlantic avenues. 1700 w. R R Gaz—April 1, 1904. No. 61850.

Train-Sheds.

Experience with Skylight Construction for Railway Train Sheds. A record of experience showing that no form of construction gives enduring service under existing conditions, and that the failure is due to the distortion and destruction of the framework. 5000 w. Eng News—April 21, 1904. No. 62176.

Water Station.

Water Supply at the Halensee Station (Wasserstation auf Bahnhof Halensee). M. Buhle. Illustrating water tower, tank, and pumping plant in the environs of Berlin; capacity 3,000 cubic metres per day. 1000 w. Zeitschr d Ver Deutscher Ing—March 26, 1904. No. 62203 D.

Yards.

The Fairview Yard, Northern Central and P. R. R. Plan and description of improvements made to relieve a serious congestion in the Harrisburg yard. 700 w. R R Gaz—April 15, 1904. No. 62115.

MISCELLANY.

Pennsylvania.

The Beginnings of Railroading in Pennsylvania. From notes by Col. A. K. M'Clure, in the *Philadelphia Press*. Interesting facts from the early history of railroading. 2500 w. R R Gaz—April 8, 1904. No. 62005.

Progress.

Recent Technical Progress on the Railways Belonging to the German Railway Union. Translated from *Zeitung des Vereins*. A summary of the important conclusions in the report of the Technical Committee. 7500 w. Bul Int Ry Cong—March, 1904. No. 61795 E.

STREET AND ELECTRIC RAILWAYS

Alternating Current.

Single versus Multiphase Generators in Alternating Current Railway Work. W. A. Blanck. Considers the relative merits of the two systems, discussing typical cases using one, two, and three-phase generators. 1600 w. St Ry Jour—April 9, 1904. No. 62029 C.

Arnold System.

The Arnold Electro-Pneumatic Railway System. Bion J. Arnold. Illustrated detailed description, stating the principles underlying the system. 4000 w. Sib Jour of Engng—April, 1904. No. 62308 C.

Ashes.

Disposal of City Ashes as an Adjunct of Street Railway Business in Brooklyn. Illustrated description of the arrangements made by the Brooklyn Rapid Transit Co. for the removal and disposal of ashes, street sweepings and rubbish. 3000 w. St Ry Jour—April 23, 1904. No. 62368 C.

Berlin.

A North-South Berlin City Railway. D. Feldmann. Translated from *Zentralblatt der Bauverwaltung*. Discusses the location of such a line, and the construction. Thinks it is only possible if built sufficiently high to cross over the houses. Map. 2500 w. Bul Int Ry Cong—March, 1904. No. 61794 E.

Birmingham, Ala.

Birmingham Railway, Light & Power Co. Thomas de Granville. An illustrated article describing the system, which is a consolidation of fifteen companies, the track, overhead construction, buildings, rolling stock, &c. 8400 w. St Ry Rev—April 20, 1904. No. 62380 C.

Bogie Motors.

The Position of Motors on Bogie Carriages. B. Pontifax. A discussion of where the motors ought to be fixed, and where bogie cars should be placed on the trains. Introductory to a general discussion. 1200 w. Elec. Engr, Lond—March 25, 1904. No. 61928 A.

Conduit Railway.

A Conduit Electric Railway in London, England. Information concerning this line, with map and illustrations. 3700 w. Eng News—April 21, 1904. No. 62180.

Current Collecting.

A New System of Current Collecting for Heavy Electric Traction Lines. Henri Somach. Illustrated description of a system devised by E. Huber of the Oerlikon Machine Works, of Switzerland, discussing the points of merit. 3000 w. St Ry Jour—April 23, 1904. No. 62369 C.

Earth Connections.

Protected Earth Connections for Electric Railways (Ueber einen Geschützten Erdleitungsanschluss an Eisenbahnschienen). A. Frey. Illustrating a covered bonding of the rails with a continuous earthing wire. 1000 w. Elektrotech Zeitschr—March 17, 1904. No. 62253 B.

Electric Branches.

Some Operating Data from the Concord & Manchester Branch of the Boston & Maine R. R., Concord, N. H. An illustrated series of articles, explaining methods of dispatching, collecting and registering fares, and the design and equipment of standard cars. 6000 w. St Ry Rev—April 20, 1904. No. 62379 C.

Electric Control.

The Automatic Regenerative Control for Electric Tramways. An illustrated description of a new system of automatic regenerative control worked out by J. S. Raworth, and put in daily service at Davenport, England. 2200 w. Trac & Trans —April, 1904. No. 62080 E.

Interurban.

The Lackawanna and Wyoming Valley Railroad. George B. Francis. Illustrated detailed description of a standard-gauge, double-track, rock-ballasted, third rail electric road on a private right of way, laid with 90-pound rail. Extends from Scranton to Wilkesbarre. 3500 w. Jour Assn of Engng Socs—March, 1904. No. 62312 C.

Los Angeles.

Notes on Los Angeles Railway Company's System. An illustrated description of the features of interest in the rolling stock, car houses, and methods of operating of this company. 3500 w. St Ry Jour —April 9, 1904. No. 62028 C.

Main-Lines.

Developments in Heavy Electric Traction. C. L. de Muralt. Discusses the alternating current systems in use, and the problems connected with the electrification of existing steam roads. 1500 w. R R Gaz—April 15, 1904. No. 62116.

The Electrical Equipment of the Liverpool & South-Port Division of the Lancashire & Yorkshire Railway. Illustrates and describes the equipment of the first English steam railway with electrically-equipped multiple-unit trains. 9200 w. St Ry Jour—April 2, 1904. No. 61875 C.

Single Phase.

Single-Phase Railways. W. A. Blanck. Considers the fundamental characteristcs of various single-phase railway motors, details of line construction, and comparative cost of direct-current and alternating-current systems. Ills. 3500 w. Trans Am Inst of Elec Engrs—Feb. 15, 1904. No. 62188 D.

The Westinghouse Single-Phase Railway System. Clarence Renshaw. An illustrated detailed description of the various features of the system, and its advantages as compared with the present direct-current system. 4000 w. Elec Club Jour—April, 1904. No. 62105.

Stray Currents.

Electrolysis as Caused by the Railway Return Current. Albert B. Herrick. Reviews the fundamental laws governing electrolysis and the remedies that have been most successfully employed. Gives the outcome of investigations covering many of the largest cities in the United States. Ills. 7300 w. St Ry Jour—April 2, 1904. No. 61876 C.

Substation.

The New Dock Street Substation of the Schenectady Railway Company, Schenectady, N. Y. Illustrated detailed description. 2000 w. Elec Rev, N. Y.—April 23, 1904. No. 62371.

Third Rail.

A Protected Sectional Third-Rail System of Electric Traction. Illustrates and describes the Farnham system which not only protects the rail from contact, but distributes the current so that the section will be energized only while the car is passing. 2000 w. Eng News—March 31, 1904. No. 61845.

Tracks.

Rail Joints and Pavements. C. R. Van Buskirk. Read before the Brooklyn Engrs.' Club. Considers modern methods of welding rail joints. 2800 w. Munic Jour & Engr—April, 1904. No. 61874 C.

Some Improvements in Track Construction in Philadelphia. C. B. Voynow. An address before the Phila. branch of the Am. Inst. of Elec. Engrs. An illustrated description of the joints at present used, explaining their advantages, and of the improved methods of holding the rails to line and gage. 3500 w. St Ry Jour—April 2, 1904. No. 61877 C.

Tyrol.

The Mendel Railway (Die Mendelbahn). Oskar Meltzer. A fully illustrated account of the electric and cable railway from Bozen to the summit of the Mendel Pass in the Tyrol. Two articles. 8000 w. 2 plates. Oesterr Wochenschr f d Oeffent Baudienst—March 26, April 2, 1904. No. 62247 each D.

EXPLANATORY NOTE—THE ENGINEERING INDEX.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language,* together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. Certain journals, however, make large extra charges for back numbers. In such cases we may have to increase proportionately the normal charge given in the Index. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

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CARD INDEX.—These pages are issued separately from the Magazine, printed on one side of the paper only, and in this form they meet the exact requirements of those who desire to clip the items for card-index purposes. Thus printed they are supplied to regular subscribers of THE ENGINEERING MAGAZINE at 10 cts. per month, or $1.00 a year; to non-subscribers, 25 cts. per month, or $3.00 a year.

THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w,* a bi-weekly, *s-w,* a semi-weekly, *m,* a monthly, *b-m,* a bi-monthly, *t-m,* a tri-monthly, *qr,* a quarterly, *s-q,* semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* Boston.
American Electrician. *m.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Jl. of Science. *m.* New Haven, U.S.A.
American Machinist. *w.* New York.
American Shipbuilder. *w.* New York.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. d Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *qr.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Sydney.
Autocar. *w.* Coventry, England.
Automobile. *m.* New York.
Automobile Magazine. *m.* New York.
Automotor Journal. *w.* London.
Beton und Eisen. *qr.* Vienna.
Brick Builder. *m.* Boston.
British Architect. *w.* London.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bulletin American Iron and Steel Asso. *w.* Philadelphia, U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. Soc. Int. d Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bulletin Univ. of Kansas. *b-m.* Lawrence.
Bull. Int. Railway Congress. *m.* Brussels.
California Jour. of Tech. *m.* Berkeley, Cal.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Montreal.
Canadian Mining Review. *m.* Ottawa.
Cassier's Magazine. *m.* New York.
Central Station. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *m.* Chicago.

Electrical Engineer. *w.* London.
Electrical Review. *m.* London.
Electrical Review. *w.* New York.
Electrical World and Engineer. *w.* New York.
Electric Club Journal. *m.* Pittsburg, Pa.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *w.* New York.
Electrochemical Industry. *m.* New York.
Electrochemist and Metallurgist. *w.* London.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Chicago.
Engineering. *w.* London.
Engineering and Mining Journal. *w.* New York.
Engineering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Engineering Review. *m.* London.
Eng. Soc. of Western Penna. *m.* Pittsburg, U.S.A.
Engineering Times. *m.* London.
Fire and Water. *w.* New York.
Foundry. *m.* Cleveland, U. S. A.
Gas Engineers' Mag. *m.* Birmingham.
Gas World. *w.* London.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e. d. Str. Ferr. *w.* Rome.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Ice and Refrigeration. *m.* New York.
Ill. Zeitschr. f. Klein u. Strassenbahnen. *s-m.* Berlin.
Ingenieria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron and Steel Metallurgist. *m.* Boston.
Iron and Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. Am. Foundrymen's Assoc. *m.* New York.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Journal of Sanitary Institute. *qr.* London.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery *b-m.* Fort Monroe, U.S.A.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, U.S.A.
Locomotive. *m.* Hartford, U. S. A.
Locomotive Engineering. *m.* New York.
Machinery. *m.* New York.
Madrid Cientifico. *t-m.* Madrid.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U. S. A.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Metal Worker. *w.* New York.
Métallurgie. *w.* Paris.
Minero Mexicano. *w.* City of Mexico.
Minerva. *w.* Rome.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci Press. *w.* San Francisco.
Mining Reporter. *w.* Denver, U. S. A.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
Modern Machinery. *m.* Chicago.
Mouvement Maritime. *w.* Brussels.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *m.* New York.
Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Nineteenth Century. *m.* London.
North American Review. *m.* New York.
Oest. Wochenschr. f. d. Oeff. Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg- & Hüttenwesen. *w.* Vienna.
Ores and Metals. *w.* Denver, U. S. A.
Pacific Coast Miner. *w.* San Francisco.
Page's Magazine. *m.* London.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Proceedings Engineers' Club. *qr.* Philadelphia.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Progressive Age. *s-m.* New York.
Quarry. *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago
Review of Reviews. *m.* London & New York.
Revista d Obras. Pub. *w.* Madrid.
Revista Tech. Ind. *m.* Barcelona.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Gen. des Sciences. *w.* Paris.
Revue Industrielle. *w.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Gen. d Ferrovie. *w.* Florence.
Rivista Marittima. *m.* Rome.
Schiffbau. *s-m.* Berlin.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Engng. *m.* Ithaca, N. Y.
Stahl und Eisen. *s-m.* Düsseldorf.
Stevens' Institute Indicator. *qr.* Hoboken, U.S.A.
Stone. *m.* New York.
Street Railway Journal. *m.* New York.
Street Railway Review. *m.* Chicago.
Tijds. v h Kljk. Inst. v Ing. *qr.* Hague.
Traction and Transmission. *m.* London.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Transport. *w.* London.
Wiener Bauindustrie Zeitung. *w.* Vienna.
World's Work. *m.* New York.
Yacht. *w.* Paris.
Zeitschr. d. Mitteleurop. Motorwagen Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochcemie. *w.* Halle a S.
Zeitschr. f. Elektrotechnik. *w.* Vienna.

CURRENT RECORD OF NEW BOOKS

NOTE.—Our readers may order through us any book here mentioned, remitting the publisher's price as given in each notice. Checks, Drafts, and Post Office Orders, home and foreign, should be made payable to THE ENGINEERING MAGAZINE.

Cranes.

An Elementary Treatise on Hoisting Machinery, including the Elements of Crane Construction and Descriptions of the Various Types of Cranes in Use. By Joseph Horner, A. M. I. M. E. Size, 8 by 5½ inches; pp. xii. 252; illustrations, 228. Price, $3 (7s. 6d.). Philadelphia: J. B. Lippincott Company. London: Crosby Lockwood and Son.

Electric driving has opened up a new era in the crane industry, and hoisting machinery of all kinds has had its field of usefulness widely extended by the application of electric power. The various modifications of construction which have been evolved in correspondence with the change in motive power, are, however, based on the older designs of cranes, and in order to get a thorough grasp of the subject of hoisting machinery, it is therefore necessary to become acquainted with the fundamental principles of design and the practical methods which have been developed through long years of shop experience. In the present book, the "shop" method of treatment has been adopted, and the various types of cranes are handled in a very practical manner. The first part of the volume is devoted to the details of cranes in general, the different parts being described and illustrated with great care. In this way the elements of crane construction are firmly established, and the reader is prepared to apply these principles to the several types of cranes which are described in later portions of the book. Sections are also devoted to the various methods of operating cranes, by hand, steam, water, air and electricity, and to the materials used in their construction. All this, written by a man of long experience in the work of crane construction, makes a very useful book of great practical value.

Drawing.

Compendium of Drawing. Two volumes. Size, 9½ by 6½ in.; pp. 415 and 483; many plates and illustrations in the text. Price, per volume, $5, per set $8 (until June 1st $3 and $5, respectively). Chicago: American School of Correspondence at Armour Institute of Technology.

Within recent years, the enormous growth of correspondence schools shows that the instruction given by them supplies a real need which is felt by those unable to take a college course and who yet desire to gain knowledge which will help them in their work and will improve their positions. The field of activity of these schools has steadily widened and their courses have been developed by competent instructors, while some institutions have had the benefit of the advice and direction of leading men in the educational profession. In the course of experience, it has been found necessary to prepare special instruction papers to suit the needs of correspondence students and these papers, in some instances, have grown into text books which, among their other good qualities, are concise and eminently practical and go directly to the point, as they are addressed primarily to people who appreciate plain language and clear directions and who have no time to waste. With the increasing excellence of these text books, their scope has been widened, so that now they not only are used by correspondence students, but also find a place as works of instruction and reference for those who have not time to take a correspondence course, and even for those who are studying at a regular engineering college. Among the best of these books is the present compendium, which, while comprising only about a dozen out of nearly ninety instruction papers used in the drawing courses of the American School of Correspondence, contains the essentials for the beginner in mechanical and architectural drawing and starts him in the right direction. The information is given in a clear, direct manner and is profusely illustrated by figures in the text and many plates. The two volumes comprise the following principal parts, each prepared by an authority in his line: Mechanical drawing; shades and shadows; perspective drawing; pen-and-ink rendering; architectural lettering; working drawings; mechanism; machine design; sheet-metal-patter drafting; and tinsmithing. Attached to each section are examination papers, so that the student is enabled to test his knowledge as he goes along. Owing to the range of subjects, as well as on account of the way in which they are treated, this work will be found useful not only by the beginner, but also by the advanced student and the professional draftsman.

Framed Structures.

The Theory and Practice of Modern Framed Structures. By J. B. Johnson, C. E., C. W. Bryan, C. E., and F. E. Turneaure, C. E. Eighth Edition. Size, 11 by 8½ in.; pp. ix, 561; plates, 50; figures, 451. Price, $10. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

Bridge practice is developing so rapidly and new varieties of framed structure, notably the skeleton building, are coming into such general use, that a new edition of this standard work, partly rewritten and brought up to date, is very welcome. Unfortunately, its chief author, Prof. Johnson, whose untimely death was such a great loss to the engineering profession, which is indebted to him for founding *The Engineering Index,* for writing several other engineering works and for his promotion of sound engineering education, did not live to see this treatise in its latest form, but his co-authors have done their part in a most satisfactory manner. The theoretical portion of the book has been so modified as to best meet the needs of students and beginners, although the professional engineer has been by no means lost sight of. The latter class of readers will be perhaps most attracted by the chapters on structural designing, some of which, such as that on the aesthetic design of bridges, which subject is happily beginning to receive more attention in the United States, and that on tall-building construction, are of special interest at the present time, as is also an appendix by Frank W. Skinner on American methods of bridge erection, adapted from a lecture delivered at Cornell University. The volume is profusely illustrated with figures in the text and with plates containing details of structures and views of some of the notable bridges in Europe and America. Altogether the work will prove a most valuable one, both for the use of schools and for engineers in professional practice.

Friction.

A Treatise on Friction and Lost Work in Machinery and Millwork. By Robert H. Thurston, M. A., LL. D., Dr. Eng'g. Seventh Edition. Size, 9 by 6 in.; pp. xi, 430; figures, 77. Price, $3. New York: John Wiley & Sons; London: Chapman & Hall, Ltd.

Of the great amount of work done by the late Professor Thurston, by which he made the whole engineering profession his debtor, those parts relating to friction and lubrication are among the most valuable. He had a thorough knowledge of the history of engineering, and possessed the happy faculty of clearly analyzing the work of other engineers and systematically setting forth their conclusions, while, in addition, he enriched many branches of engineering with his own researches. These various aspects of his genius are well shown in the present work, which has progressed through successive editions, in order to meet a steady demand and to keep pace with the advances in engineering, until this latest one, which, unfortunately, will also be the last revised by his own hand. The larger portion of this book treats of the theory of friction, lubricants and lubricating apparatus, the testing of lubricants and experiments on friction, and other matters relating to the technical side of the subject. But there is also a chapter on "The Finance of Lost Work and the Valuation of Lubricants," which shows, both by analysis of principles and by practical examples, that it is the sum of the costs of wasted power and of lubrication, and not merely the cost of the lubricant, which is to be minimized. The insignificance of the cost of lubrication compared with the power that can be saved by reducing friction clearly indicates the importance of using the lubricant best adapted to any particular purpose, without regard to its price. A new chapter has been added, giving a summary of recent investigations in friction and lubrication, and containing, among other things, an account of Lasche's studies of bearings for high speeds, preliminary to the Zossen high-speed electric railway experiments. In the course of the years since the first edition of this work was issued it has had a strong influence in promoting a sounder knowledge of the principles of friction and lubrication and in improving practice, and the author had the satisfaction of living to see much of his pioneer work confirmed by followers in his steps and his early views accepted by the engineering profession.

Health Board.

Thirty-Fourth Annual Report of the State Board of Health of Massachusetts. Size, 9 by 6 inches; pp. li, 623: Boston: State Board of Health.

The high state of civilization and public spirit in Massachusetts is well shown by the activities which these reports of the State Board of Health describe, as well as by the reports themselves. The present volume, for 1902, has its greater part devoted to water supply and sewerage, under which heads are given advice to cities and towns in reply to inquiries addressed to the Board of Health; the examination of water supplies, and experiments on the purification of sewage and the water filtration and bacteriological studies at the famous Lawrence Experiment Station. There are also reports upon food and drug inspection, diphtheria antitoxin, diphtheria cultures, examinations for tuberculosis, typhoid fever and malaria, statistical summaries of disease and mortality and a report on the health of towns. An index completes a public document which has a wide sphere of usefulness and does credit to the Board and the State issuing it.

Railroad Earnings.

The Earning Power of Railroads. By Floyd W. Mundy. Size, 7½ by 5 in.; pp. 244. Price, $1.25. New York: Metropolitan Advertising Co.

Balance sheets alone do not supply all the information desirable for an intending investor in railroad securities. To get a complete idea of the value of such stocks and bonds, a careful investigation should be made also of a road's physical condition and of the possible development of traffic. But a careful analysis of reports, with an indication of the real meaning of the various items, will be a great help, and it is the object of the present book to give the statements issued by the principal railroads of the United States and Canada, together with the interpretation thereof. There are tables showing the earnings, capitalization, mileage and other statistics of 112 railroads, with notes which explain and amplify these reports. Besides the statistics, which occupy the body of the book, there are introductory chapters which discuss the true significance of maintenance expenses, conducting transportation and general expenses, fixed charges, the "operating ratio," and the various other features of railway accounting, so that the investor in railroads, as well as the student of railroad economics, can read the reports which are now issued with considerable uniformity by the railroads of the United States, under the direction of the Interstate Commerce Commission, with understanding and profit.

Transformers.

The Alternating-Current Transformer. By F. G. Baum. Size, 7½ by 5½ in.; pp. 195; figures, 122. Price, $1.50. New York: McGraw Publishing Co.

While the fundamental principles of transformer construction are the same as they were in the early days of alternating-current engineering, the details of design have improved vastly, so that there has been a great reduction of iron and copper losses and the regulation is far better. More attention is also given to what may be called the auxiliary features of transformer design, but which are of the greatest importance in securing efficient operation, such as insulation and cooling, but as was brought out at a recent meeting of the American Institute of Electrical Engineers, there is still much room for improvement in this direction, and with the increasing voltages which are demanded in long-distance transmission work, such improvements will have to be made. In the present work, which originated from a course of university lectures, the theory of the transformer is set forth in a clear and orderly manner, and enough of current practice is described to give the reader a very good idea of that side of the subject. After the introductory part of the book, the theory of the transformer is studied from the point of view of the changing magnetism, rather than of the varying currents directly, and there are chapters on the graphical representations of pressure relations, regulation and efficiency. Testing forms the subject of one chapter, and the systematic design of transformers is laid down in another. Other chapters are devoted to circuit regulators, constant-current transformers, series transformers, compensating voltmeters, and connections of transformers for single-phase and polyphase circuits. The last chapter describes various commercial types of transformers, while an appendix contains some extracts from the rules of the U. S. National Board of Fire Underwriters. Altogether, the book gives a very good account of its subject, and will be a useful one for the engineer as well as for the student.

BOOKS RECEIVED.

Practical Laws and Data on the Condensation of Steam in Covered and Bare Pipes. By Charles P. Paulding. M. E. Price, $2. New York: D. Van Nostrand Company.

Proceedings of the First General Convention to Consider the Questions Involved in Mosquito Extermination. The National Mosquito Extermination Society, H. C. Weeks, Sec'y, Bayside, L. I., New York City.

Towers and Tanks for Water-Works. By J. N. Hazlehurst. Price, $2.50. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

The Non-Metallic Minerals, Their Occurrence and Uses. By George P. Merrill. Price, $4. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

Architects' and Engineers' Handbook of Reinforced Concrete Constructions. By L. J. Mensch. Price, $2. Chicago: Cement and Engineering News.

Naval Architecture. By Prof. Cecil H. Peabody. Price $7.50. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

Engineers' Arithmetic. By Fred. H. Colvin and Walter Lee Cheney. Price, 50 cents. New York: The Derry-Collard Co. London: The Locomotive Publishing Co., Ltd.

THE
ENGINEERING MAGAZINE
"THE WORLD IS ITS FIELD"

VOL. XXVII. JULY, 1904. No. 4.

THE CONDITIONS OF MAXIMUM PRODUCTIVE EFFICIENCY.

By Ralph Neville, K. C.

In modern industrial competition for world trade, as Mr. W. L. Clark pointed out in our May issue, Great Britain has the advantage of long undisputed supremacy; Germany, that of a highly perfected commercial system; the United States, the support of the best home market in the world, stimulating specialized manufacturing. The same labor-saving machinery is available to all; the best mechanical practice is substantially public property, open for any to adopt. Mr. Neville's discussion is most significant because he points out that the other factors—the ultimate factors—in the total efficiency of a nation as a producer, are to be found in elements which lie at the very bottom of the social and industrial order. He takes as his text his own country—England—but his argument is no less instructive for either of the other great competitors for the world's engineering trade.—THE EDITORS.

THE history of British industrial development during the last century has been marked by a long period of supremacy almost unchallenged, followed by a short period during which British commerce has been subject to severe competition and has in the result been overhauled with a rapidity quite unexpected. A marked decline in initiative has accompanied this change in position. Heretofore the leaders of the world in the introduction of inventions and the application of new methods and facilities, latterly we have been falling behind; while awakening anxiety exhibits itself rather in a halting endeavour to imitate our rivals, than by any new departure distinctly British. The history of electric lighting, telephonic communication, motor traffic, submarines, and standardisation in the steel trade, serves to illustrate our backwardness; indeed it is not easy to recall any recent practical development in which British industry has asserted its old position as pioneer.

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Opinions differ widely as to the significance of these symptoms, but they are no longer dismissed as the morbid creations of a diseased pessimism. It is improbable that the true remedy for our unsatisfactory position will be found in the imitation of the methods of our rivals, for we are in a later stage of industrial development than they, and are already face to face with difficulties which they have not reached. What is with us at once so necessary and so much to seek, is a clear perception of the conditions essential to industrial efficiency and progress.

The product of the activity of any human society depends upon the character of the individuals composing it, and the character of the individuals composing it directly depends upon the conditions under which the society by choice or necessity lives. The connection between cause and effect in this regard is, in striking instance, generally recognised. The hardihood of the mountaineer is proverbial; slavish characteristics are rightly attributed to the servile condition; as yet, however, it is imperfectly understood, that every characteristic of nation or class has an equivalent cause underlying it, and that amendment of any shortcoming can be arrived at only by the identification and modification of the condition of life to which it is attributable.

Applying these considerations to communities engaged in competitive commercialism, it becomes obvious that, other things being equal, that community will excel in which the conditions of life most tend to ensure diligent application to business. Attention in Great Britain has recently been directed to an alleged excessive addiction to pleasure, among those who may be roughly included in the capitalist class, and to an alleged apathy in the performance of their tasks, on the part of the working class. Assuming these allegations to be correct, they show the existence of two serious obstacles to efficiency; while if the above observations concerning cause and effect are well founded, the cause of these characteristics should be capable of identification, and remediable by appropriate modifications of our social system, so far as it is founded on choice and not upon necessity. It will appear, as we proceed, that necessity has very little to say in the matter. It becomes therefore important to enquire, whether in British social life there exist conditions calculated to produce such characteristics, and the contention which I shall endeavour in this article to sustain is, that in the conventional ideas prevailing in consequence of the undue persistence of feudal conventions and in the method of the remuneration of labour, are to be found causes quite sufficient to account for the appearance of the characteristics complained of.

In the first place, it may be readily demonstrated that the retention in the social system, of conventions founded upon feudalism, is not, as is generally supposed, merely a picturesque and harmless survival, but that, on the contrary, it is a potent cause, having a far-reaching effect upon national efficiency. It is necessary at the outset to define the meaning of the conventions and conventional ideas spoken of above. By conventions is intended a social arrangement whereby a condition of society not dependent upon natural causes is produced by agreement, expressed or implied, between those who enjoy and those who suffer it. From these conventions flow ideas which are entertained by the people in general, and inasmuch as, of necessity, in any society of human beings, the unalterable realities of life are enormously outnumbered by the conventions by which they are overlaid, it follows that the bulk of the ideas entertained by the majority of mankind are conventional only. Inasmuch, therefore, as the most of men's actions are the result of the ideas they entertain, the actions of men in a social state are to a very great extent the result of the ideas flowing from the conventions which they consciously or unconsciously accept. Consequently the utility of the aggregate of the actions of any human society is largely dependent upon the character of the conventions under which the members of such society live, and their appropriateness to the ends to which the efforts of the latter are professedly directed.

Conventions, in their inception, are directed to the attainment of definite ends, and are usually fairly well adapted to the necessities of the case which they are intended to meet. Hereditary rank and hereditary wealth are good illustrations of pure conventions. They depend upon no natural law, but are founded simply upon supposed convenience and utility. With the conventions regulating the disposal of property after the owner's death we are not at present concerned. Tracing back the history of the convention upon which, to the present moment, the ideas connected with rank are founded, we find it established in feudal times, while the making of the nations was in progress. It was designed to enhance the dignity of those to whom was assigned the administration of law within their territories, and the provision and command of the armed forces of the feudal State, and at the same time to secure an orderly succession to the office. We may note in passing, with edification, the practical good sense of our ancestors, who, differing in this respect from the continental States, limited the inequality conferred by rank to the necessities of the case, and withheld its dignity and privileges from all but the actual holders of the feudal office—a wise limitation which bore good fruit in the subsequent development of the country. Now any convention which tended to increase the respect of the people for their rulers was obviously a wise convention from the feudal point of view; but the tendency of conventions which have outlived the purposes for which they were constituted is to become obstructive and injurious. It is in the last degree improbable that a convention appropriate to secure a particular end under particular social conditions, should prove to be the appropriate convention to secure another, and quite different end, under other and quite different social conditions. By the change of the structure and objects of society, the utility of this particular convention has determined, while the conventional ideas founded on it, which attribute merit to the possessor of rank and title, remain but little impaired. Out of the numerous instances which might be adduced to establish the accuracy of the last statement, the following will probably suffice. It is a forcible instance, inasmuch as it shows the idea of merit attaching to rank operating in what would appear to be the most unlikely way, under the most unlikely circumstances. Probably no class supplies less efficient directors of limited companies than that composed of peers of the realm, and their immediate relatives; yet company promoters are well aware that the insertion of titled names upon the front page of a prospectus is the readiest road to the public pocket. Repeated exposure of the character of the concerns with which such names have been connected has had little or no effect upon the fascination which they exercise over the public mind. Probably not one in a hundred of those who subscribe their money upon the faith of a great name appearing upon a prospectus—and lose it—could give any intelligible account of the train of thought which led them to apply for shares. They would be the first to ridicule the notion that their loss was due to the undue persistence of a fuedal convention; yet such can readily be shown to be the fact. It appears, then, that not only do ideas flow from conventions, but that these ideas bear practical fruit. Indeed, it is inevitable that where the State confers distinction upon a particular class, that distinction will be associated in the popular mind with merit, and, if the favoured class are not in any particular manner distinguished by merit, then whatever they happen to be distinguished for will be taken, or mistaken, for merit. An hereditary aristocracy, deprived of its occupation and surviving the objects of its existence, inevitably degenerates into a mere pleasure-seeking class. It is as leaders of a society composing an idle class that members of the aristocracy appeal to the popular mind; and where as with us there is no hard and fast line between classes, the aims and ambitions of every class are largely founded upon the habits of the class above it. Under the present social conditions created and maintained by the State, a natural and inevitable association of ideas leads the public to regard wealth in idleness, not only as the most enjoyable, but as the most honourable, manner of existence; and to esteem business only so far as it conduces to such an end. The truth that in the full exercise of his faculties, lies not only the duty of man, but also the only true source of his enjoyment, is a hard saying; and, in a community seeking efficiency, no effort should be spared to promote the idea that the sole title to esteem consists in what a man is and does, and not in what he has. The deliberate retention of conventions tending to ideas pointing in precisely the opposite direction, cannot fail to materially pervert men's minds from the rational conceptions of existence which lie at the root of the efficient conduct of life.

Immediately connected with the conventional idea which has been considered is the idea of "gentility," entertained in the sense that useful labour is degrading to a "gentleman"; an idea carried so far that "gentleman" came to signify anyone who lived without working, and was legally decided to be the proper description of a solicitor's clerk out of employment. The effect of this perverse idea has been prodigious. It accounts for the low social estimation in which trade and manufacture has been held in Great Britain—a fact which, in its turn, has for generations diverted the more highly educated young men from the pursuit of trade, and divorced the universities from the active life of the country. On the other hand, the abstention from trade of the highly educated led to the association of the idea of imperfect education with that of trade, and, at the same time, fostered in traders a mistrust of the higher education which they believed to unfit a man for business. British commercial development has consequently been retarded by the artificial exclusion of much of the best intelligence of the country from commerce, and at the same time by the imperfect development of the intelligence of those engaged in it; in both cases occasioned by the prevalence of a false conventional idea.

We are not however left to *a priori* reasoning to establish the effect of feudal conventions upon an industrial community. More than a century ago the colonists of America shook themselves free from the trammels of feudalism, and we are enabled to compare the progress of a nation, free from feudal conventions, with that of the same people left under the influence of their historic institutions and environment. We find in America trade comparatively unhampered by the drawbacks which we have traced to the survival of feudal conventions. Idleness is there not highly esteemed, the display of the energy and capacity necessary to acquire wealth is deemed a higher merit than the possession of wealth itself; the fact that a man owes his wealth to his own exertions there increases, instead of, as in Great Britain, diminishing the estimation in which a wealthy man is held. It is true that America is rapidly acquiring an idle class (rumours of their follies and extravagancies occasionally reach us) for which in due course they will pay the penalty; but it is not large enough, nor has it existed long enough, to affect seriously the conventional ideas of the people; and at least the nation at large avoids the folly of imparting to this class a fictitious importance, by conferring rank and title upon its members. Turning to the question of education we find that in America education is not divorced from business, but the graduate of the university seeks employment in trade, and the man of business looks to the graduate of the university for intelligent assistance. The effect of general education operates essentially towards enlarging the mind and broadening the views, and a country where general education is recognised as the essential basis for technical acquirements, necessarily obtains an advantage in industrial effort over one in which the ignorant notion prevails, that the best preparation for a commercial career is early initiation into the narrow routine of a particular business. As therefore these considerations would lead us to anticipate, we find American employers sparing no expense to reduce the cost of production, and grudging no remuneration to secure the efficiency of labour; while the trades unions, content with the maintenance of a minimum wage, throw little obstacle in the way of the further remuneration of labour in proportion to the work done; in these respects contrasting favourably with British manufacturers and trades unionists. We are forced then, both by reason and experience, to the conclusion, that in the retention of obsolete conventions not appropriate to secure efficiency in business, lies a cause calculated to produce in the capitalist class the very attitude of mind towards business alleged against it; and the truth of the first proposition has been sufficiently established.

With reference to the question of hereditary rank, it is of course neither proved nor alleged that there are not many members of the favoured class in question worthy of the highest esteem; but this consideration only enforces the argument used in that connection, for the respect in which these persons are popularly held is independent of their individual merit, and would remain practically unaltered by its elimination. This is proved by the fact that they share it with others, in whom the merit is nonexistent.

In proceeding to the examination of the second proposition, namely, that the apathy of the working class can be accounted for by the method of their remuneration, attention must be directed to certain conditions involved in the existing relations between capital and labour. In the first place, it is to be noted that where, as in Great Britain, the supply of labour is always somewhat in excess of the demand, the power of dismissal vested in the employer gives him *prima facie* the absolute control over wages; and there is nothing to compel him to maintain them above the point necessary to render the employee temporarily capable of performing the task set him. That wages do actually fall to this point where combination is not resorted to and the conditions stated exist, is shown by the trades in which women are chiefly employed. In such cases the wages paid are often not sufficient to support the life of the employee during its natural term, or anything approaching its natural term. This absolute authority on the part of the employer can, in the absence of legislative interference, be limited only by combination among the employees. Such combination deprives the employer of the power of dealing with any individual in his employ, and compels him to deal with a body which has the power to deprive him, at all events for the time being, of the labour necessary for his enterprise. Combination is therefore, for labour, a prime necessity, and so long as the objects of trades unions are confined to securing a sufficient minimum wage and conditions of labour essential for the health of the employed, their existence tends to the benefit of the whole community, whose first interest lies in securing for all, means of existence compatible with healthy physical development. If the working class could not and did not, to a considerable extent, protect their own interests by combination, legislative protection would be inevitable; while the majority of the Anglo-Saxon race believe the legislative control of individual action to be injurious to the independence of spirit and moral fibre of the individual affected, and oppose its application except in the last resort. We find therefore that the limitation of the power of dismissal by the employer, by labour combination, is an essential condition for the well being of labour and of the State; and, consequently, we must consider the question of the remuneration of labour from the standpoint that trades unions will continue, and ought to continue to exist. The effect of the curtailment of the employer's power of dismissal is not, however, exhausted by its operation upon wages. The employer must *prima facie* rely upon it not only for the regulation of wages, but for the enforcement of the employee's task. Under the wage system the employee has no incentive to exertion beyond the fear of dismissal, and the crippling of the power of dismissal leaves the employer to a considerable extent at the mercy of the trades unions, with regard to the quantity and quality of the work done. In any restriction of effort in which the employee can obtain the support of his union, he is safe from dismissal by any employer who has to accept the conditions of the union; while the exigencies of the trades unions tend to induce them to accept the capacity of the least efficient of their members, as the standard by which to measure the extent of a day's work. Where, with a too narrow regard for their immediate interests, trades unions exceed the functions suggested above as the limit within which their action is beneficial, employers under the wage system must either put up with inefficient labour, or engage in a costly struggle with trades unionism —a struggle in which victory would prove barren, because as has been pointed out, if trades unionism did not exist, legislative interference between employers and employed would be inevitable.

It appears, then, that under the wage system, no incentive to exertion exists, beyond what is necessary to earn the wage, and that this, under existing conditions, is likely to be reduced to a very low point. In the absence of adequate incentive to exertion, apathy is certain to prevail, in spite of the gratuitous advice and exhortation which well meaning persons continually bestow upon the working class. Patriotism, enlightened regard for the interests of British commerce, the stimulating effect of industry upon the moral nature, are in turn called in aid, to induce the working man to give a greater return for his wage than can otherwise be got out of him. In estimating the effect that such considerations are likely to have upon the working class, it is well to bear in mind, that they have no perceptible influence upon any other class in the community, so far as regards the conduct of their business. The members of other classes work for a tangible consideration personal to themselves.

The wage system therefore upon which the remuneration of the working classes is based is not calculated to promote zealous and energetic application on the part of the employee. It throws into direct antagonism the immediate interests of capital and labour; and if apathy on the part of labour does exist, as alleged, we have ascertained a sufficient cause in the method of its remuneration. The conservatism innate in the British character has, in former times of trouble, stood the country in good stead; but in the present industrial crisis it may prove its undoing; for if repugnance to change remains invincible, the wave of progress will pass by, and Great Britain will be included in the category of dying nations, which however slowly, yet surely tend to extinction or absorption by a more effective race. The energy and capacity of the English people however remain as yet unimpaired and a great opportunity is before us if we choose to take advantage of it. The growth of trusts and combines give warning that economic conditions are undergoing a profound change; while the great problems of modern existence remain unsolved. The future is to the nation which shall successfully grapple with the burning questions of the day, upon the solution of which can alone be found the true conditions of industrial efficiency. It does not pass the wit of man to devise methods of distribution which shall put an end to the anomaly involved in the coexistence of over-production and under-supply; so to regulate the relations of capital and labour as at once to close the suicidal strife between them, and to furnish to all engaged in production the incentive to exertion essential to success; so to distribute the population upon the land as to reconcile the pursuit of manufacturing industry with the physical wellbeing of the race. The social and industrial evils by which we are surrounded are the result, not of unalterable realities, but of conditions, if we would believe it, within our control. The industrial difficulty does not arise from incapacity to produce enough to satisfy the requirements of the whole population. Production under modern conditions could be indefinitely increased, did such a system of distribution prevail as to render effective the demand of the masses which at present remains unsatisfied. Over-crowding is not the result of insufficiency of land but largely of an inappropriate system of land tenure.

Efficiency is to be obtained by those only who are prepared to pay the price for it, and the price, in Great Britain, involves the sacrifice of much which is endeared by habit and prejudice. Yet to babble of efficiency while steadfastly upholding the very conditions which make against it, shows a want either of sincerity or of good sense. We cannot hope to hold our own, under modern industrial conditions, without the united effort of the whole nation, and we cannot afford to disregard the stumblingblocks which lie in the way of efficiency.

WAGE SYSTEMS AND THEIR BEARING UPON OUTPUT.

By George N. Barnes.

Mr. Barnes' article is of much value to employers and students of the labor question, because it represents the attitude of the best element of organized labor toward the newer wage systems. It is doubly interesting in its immediate connection with Mr. Neville's paper preceding, as it presents in large part the same subject from the viewpoint of another side.—The Editors.

IT is impossible, I believe, to harmonise the wage system of industry with principles of abstract justice, but it should not be beyond the wit of industrial statesmanship so to smooth its wheels that both employer and employed may extract from it the maximum of advantage for themselves and the community.

Methods of remuneration are, and must always remain, the most interesting and vital consideration connected with enlightened workshop management, because they have a direct bearing upon the human factor in production, and because upon their right adjustment depends to a large extent quiet and peaceful progress. I approach the question with a sincere desire to contribute to that result, and I will endeavour to show that the best method of labour payment is that which, while leaving each workman free to develop to the utmost his own individuality, yet secures every qualified man a fixed minimum income, supplemented by additional payment for increased output.

"The produce of labour," said Adam Smith, "constitutes the natural recompense of labour," the application of the formula, however, being confined to that "original state of things which precedes both the appropriation of land, and the accumulation of stock."

It is difficult to see why the accumulation of stock should lessen the recompense of labour, but it is certain that the ordinary time wages of the worker today bear but little relation to produce. Ownership of stock, and payment of wages by one class of people, and the rendering of services and receiving of wages by another, has brought, and to some extent has necessitated, changed points of view. There are those who regard the worker as a thing to be fed, regimented, and set in motion much in the same way as a machine tool. There are those who would tie him up to a particular employment and isolate him from his fellows by profit-sharing schemes or other forms of paternalism, and there are others again who still frankly regard the operation of self interest, and its expression in the cash nexus, as the last word to be said in regard to industrial relationship.

I believe that to get the best results from a man you must get him to apply his own free-will and power of initiative, but, at the same time, that you must not so individualize him as to prevent him making common cause with his fellows. It is not a question of the natural recompense of labour with which one has to deal today, but rather a question of how best to adjust methods of remuneration so as to yield the greatest possible productivity consistent with the welfare of the worker, and the maintenance and development of social consciousness on the part of all concerned.

Mere material productivity, it will be observed, is to me a secondary consideration, the human aspect being the first. A man may produce a good deal if his faculties are focussed in a narrow groove; he may be a veritable producing machine if divested of all fellow feeling with those about him, and engaged in a miserable scramble in which the "fittest" are the physically strong, and the morally unscrupulous. But before embarking on this course I should want to know where it will lead.

From earliest times wages have been regarded from the point of view of the dependence and economic inferiority of the worker. The highest conception of wages on that basis finds expression in Holy Writ, in the parable of the equal payment of the labourers in the vineyard, although it must be admitted that the justification offered to those who had borne the burden and heat of the day was scarce calculated to appeal to them very strongly. "To each man his penny" may be regarded as the biblical expression of democratic equality, but the further query "Is it not lawful for me to do what I will with my own?" has been the anti-social plea of tyrants of all climes and times.

For the serf of the feudal ages ways and means were adopted of adjusting wages to the cost of animal existence, and the worker was regarded quite frankly in that sense. From 1563 and, according to Thorold Rogers, for centuries onwards in Great Britain, the magistrates met from time to time to assess wages, and the assessment is said to have had regard "to the price at the time of victuals and apparel." Such is the origin or germ of the much vaunted "living wage" which, after all, is but a variant or development of the "cost of living" wage of the serf of the feudal ages. It presupposes the worker to be and perpetuates him as a mere drudge—a man without hope, stimulus, or interest in his work, but entitled only to a bare living from it, whatever the product; and it exhibits the employer as the head and cornerstone of the industrial hierarchy, and the only man with scope for initiative. In addition to this, it is now open to the further objection that time wages, under intensified competition in industry, tend to a "payment by results" basis; the remuneration received having a distinct relation—tacit or expressed—not to the value of the product, but to the amount of work done.

I believe, therefore, that the time-wage method alone is unsatisfactory—is a mere expedient, acceptable only to a habit of mind cast in a state of semi-feudalism. On the other hand, Louis Blanc's famous dictum "from each according to his ability, and to each according to his needs" depends for its realisation upon far-reaching political changes, and is applicable only to a more advanced state of civilisation. We have to deal with facts as we find them, and devise some method whereby, without destroying fellow feeling or lessening social consciousness in the workshops, men may yet be given greater interest in their work, become more efficient in it, and at the same time enabled to get more out of it.

The two modifications of the time rate which have been from time to time persistently attempted in the engineering workshops are individual piece work and profit sharing. The first has been a failure, and the second cannot be regarded as a success. In the stress of competition, piece-work earnings have tended to slide downwards to what had previously been regarded as a time-work wage, and even below it. Men with this experience in view have become less efficient because, conscious of injustice, they have lost interest in increased production; and employers, instead of finding out the cause and removing it, have railed against the men, and especially against trade-union organisations, as if trade unionists were responsible for what, after all, was the inevitable result of a defective method of remuneration.

In some cases a contract gang system has been adopted, work being let out to contractors who have hired and paid their own labour, generally on time wages, and this has led to minute subdivision of work, with consequent lowering of the general standard of skill, and an even more unsatisfactory division of the product than individual piece work. I believe that piece work has failed because it has not been accompanied by any provision for safeguarding the interests of the men.

Such provisions are, I believe, absolutely necessary, and they should include some arrangement as to fixity of the piece-work prices. They should also provide either that the employer and the men collectively should agree upon a standard list of prices; or, if the employer prefers to deal individually with the men (thus practically fixing the prices himself), that he should fix them so as to yield average earnings over and above time-rates pay, and should guarantee the payment of a minimum weekly pay to each man whom he cares to continue in employment at all. If either of these methods were adopted each man would be encouraged to work at full speed, and could do so without injury to his fellows. Individual interests would be protected by the principle of collective bargaining being given effect to; or, if an employer arranged prices with the men so as to yield additional earnings —and it would be to his interest to do so because of increased product—the men would undoubtedly earn such additional wages by increased intelligence in their work.

Profit-sharing schemes are open to objections of quite another character. I do not think that they are calculated to contribute to the permanent solution of industrial problems, although I admit that they have been advocated by many well-meaning and amiable people, and have been put into practice, sometimes with advantage, in industries where labour of a low and unorganised grade has been employed.

The profits or losses of an industrial concern now-a-days depend upon many things with which the workman has, and can have, nothing to do. Skill, or otherwise, in buying and selling, speculation, the effects of varying prices, arrangements made on this hand or on that—in short, any one of fifty things quite unrelated to the skill and efficiency of the workman concerned, may wipe out profits at any time. Moreover, ascertainment of profit can obviously be made only at long intervals of time, and workers in profit-sharing workshops are prone to remain there till profit-sharing time, and thereby they lose touch with fellow workers elsewhere. Profit-sharing schemes have indeed sometimes been inaugurated for the express purpose of thus wedding workers to particular employments and detaching them from the unions of their fellows, thus disintegrating labour into isolated and conflicting groups of workers, whereas progress is on the line of the mobility and combination of labour as well as of capital.

Combinations are necessary, not only to enable each side to protect and advance its own special interests, but to bring out the best men on both sides, and to give effect to the best means of industrial adjustment. They afford means by which men are brought together with full sense of responsibility, and armed with powers of giving effect to the largest amount of common-sense existing among them.

Another system of payment by results is the premium system, and this I believe can be so arranged as to be capable of smooth and mutually beneficial results, provided there is thorough organisation and fair dealing on each side.

It is primarily a method of increasing output and reducing cost of production, but incidentally it may also raise the position of the worker and give him greater interest in his work. It is different from piece work in two respects. First, it presupposes the payment of the time rate of wages as a basis; and second, it is less open to cutting of prices or time limits. I believe that in both these respects it is superior to piece work. The worker is automatically protected against undue cutting by the day wage being secured, and by the fact that the benefit, if any, by cutting does not all fall to the employer. As originally introduced the plan was to pay a certain fixed premium per hour saved—generally one-half—but I believe that the modification introduced some time ago by Mr. James Rowan, of Glasgow, which is known as the Rowan system, is preferable, because it still further reduces the temptation to cutting. Thus, suppose under the "half-and-half" system a job be timed 10 hours, and the worker completes it in:—

9	hours,	he	would	receive	9	plus	½	hour,	or	5.5	per	cent.	increase	of	wages.
8	"	"	"	"	8	"	1	"	"	12.5	"	"	"	"	"
7	"	"	"	"	7	"	1½	hours,	"	21.4	"	"	"	"	"
6	"	"	"	"	6	"	2	"	"	33.0	"	"	"	"	"
5	"	"	"	"	5	"	2½	"	"	50.0	"	"	"	"	"
4	"	"	"	"	4	"	3	"	"	75.0	"	"	"	"	"
3	"	"	"	"	3	"	3½	"	"	116.0	"	"	"	"	"
2	"	"	"	"	2	"	4	"	"	200.0	"	"	"	"	"

And under the Rowan system if a piece of work is timed at 10 hours and the worker completes it in

9	hours,	he	would	receive	9	plus	9/10	hours,	or	10	per	cent.	increase	of	wages.
8	"	"	"	"	8	"	16/10	"	"	20	"	"	"	"	"
7	"	"	"	"	7	"	21/10	"	"	30	"	"	"	"	"
6	"	"	"	"	6	"	24/10	"	"	40	"	"	"	"	"
5	"	"	"	"	5	"	25/10	"	"	50	"	"	"	"	"
4	"	"	"	"	4	"	24/10	"	"	60	"	"	"	"	"
3	"	"	"	"	3	"	21/10	"	"	70	"	"	"	"	"
2	"	"	"	"	2	"	16/10	"	"	80	"	"	"	"	"

Under the original plan it will be noted that the saving is divided so that the proportionate advantage to the workman—proportionate, that is, to his time wages—increases with the saving effected; thus on a "half-and-half" arrangement, a man who saved 2 hours from 10 would increase his wage by 12½ per cent.; if he saved 5 hours from the 10, his wages would be increased by 50 per cent.; and if 6 hours, by 75 per cent. These increasing gains with increasing product, therefore, would still leave temptation in the way of the employer to cut the time limits, and indeed would seem to justify it, having regard to estimated and actual time of doing a job in extreme cases. Mr. Rowan's system, on the other hand, gives the man an increase of wage equal to the saving effected from the time limit; thus if a man reduces a 10 hours limit by 2 hours, or 20 per cent., his wages would be increased by 20 per cent.; if by 3 hours or 30 per cent., 30 per cent.; and so on, the man getting a greater immediate advantage on the first saving effected, but a less, as compared with the other method, in proportion as there is greater saving.

It is sometimes objected to on the part of those who prefer to adhere to the time method of payment that the premium system is unfair, inasmuch as it does not give the worker the whole saving. In regard to this it may be pointed out that under time wages more stringent discipline may result in saving without giving the worker any advantage at all. The premium system, as compared with time payment, has the double advantage of securing greater product by the exercise of mental and manual alertness of the worker, stimulated by self interest instead of by more exacting and irritating supervision, and it secures for him part of such increased product; the remaining part going, not altogether to the employer, but part to the customer through lessened cost of production.

Objection is also sometimes raised to the premium, or bonus, plan of payment that it gives the workman only a part of the resultant saving, whereas piece work, it is said, gives him the whole of it, and it is also urged that the employer thus takes something to which he is not entitled. Thus, Mr. Frank Richards, of New York, in a paper read to his fellow members of the American Society of Mechanical Engineers, says, that the employer should pay "*pro rata* for all work turned out, as he is certainly paid in that way for all the product of his shop." I believe that the argument itself, and the statement here quoted in support of it, are fallacious. Piece-work rates are cut down so that, although under piece work the whole of the work done may be paid for *pro rata,* it by no means follows that the price is maintained at a point higher than wages, plus premium, under a premium plan. The probability is that after a very short time piece-work prices would be lower. There is, further, an implication in Mr. Richards' argument that the employer gets paid *pro rata* for increased output on a premium system, and at the same price as obtained prior to the introduction of such system, an implication that does not correspond with facts. Under competitive industry—monopoly values apart—a lessened cost of production tends, as has been said, to lower prices, so that as a matter of fact the advantage tends to the consumer rather than to the employer, the gain of the latter being rather in increased business and larger turnover on a given capital.

"Oh, but" it is then said—the old idea of a fixed quantity of work dying hard—"increased business of one employer must mean decreased business of another." The answer is that a new demand is attracted by lower prices, to what extent it is impossible to say, but at all events it is safe to say that want of work need have no terrors to engineers, in an age when electricity in its bearing upon the development of the engineering industry is just beginning to be felt.

I conclude that there are no valid economic arguments against the premium system. Provided that it is begun and continued in good faith, there being mutual agreement in fixing time limits, and extra pay given for extra time, I see no reason why it should not be operated with mutual advantage to employer and employed. But much depends upon the method of its introduction, and the spirit in which it is approached. Here the human element comes in. It may be grafted onto a workshop without serious disturbance of ordinary methods of production or workshop practice, the men being stimulated to increased effort by the ordinary play of self interest and good-will; but on the other hand, it may be thrust on a workshop so as to upset and replace existing practice, and reduce men to automata.

I should place the scheme outlined by Mr. H. L. Gantt in the latter category. As put forward by its author in a paper read to the American Society of Mechanical Engineers in December 1901, it appears really as a system of task work, the basis time being fixed, not from experience of day-work average records, but from the results of calculations carried out by one man in a workshop, and thrust by him upon all the others, thus divesting them of all power of initiative or discretion in their work. "Detailed instructions as to the way of accomplishing each of the elements of the work in the time" are provided for. "An expert mechanic has charge of what is known as the 'routing' of the piece through the shop." "The kind of tool to be used, the feed and the speed, are specified for every machine in operation," and, worse than all, provision is made for the foreman receiving "definite premium for each machine under his charge that makes bonus."

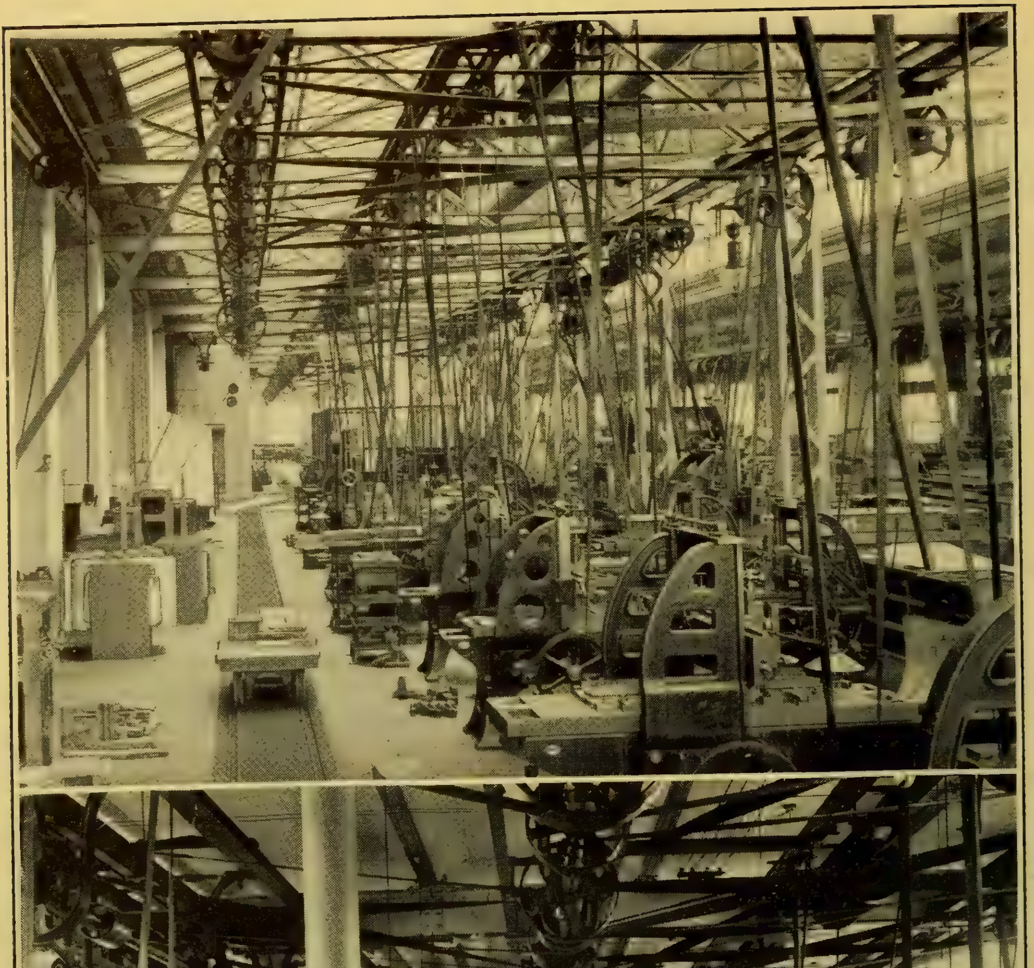
The inclusion of the foreman as receiver of premium or bonus is really the re-introduction of the old piece-master system, which wrought such incalculable injury in the engineering trade many years ago, and which has been practically abolished in Great Britain, although its effects are still seen in some industries. In the cotton-weaving trade, for instance, it has led to infamous driving of helpless female labour to such an extent as to lead not infrequently to suicide. The "router" is also quite as objectionable a person—in fact, many readers will have "rout" in mind rather than "route" in reading Mr. Gantt. The function of the "router" I should say is to harry and bully the men as much as to determine the order of the operations on a piece of work through the shop; in fact, the idea underlying the whole scheme would appear to be to harass and drive a lot of timid and spiritless men to earn a bonus, much in the same way as a donkey is spurred to increased exercise by the dangling of a carrot in front of his nose, and the "routing" of his haunches with a big stick.

No provision is made in this scheme for the payment of extra rates for extra time, which provision is a feature of the premium system as in operation in Great Britain, or for re-adjustments, or for any element of mutuality; there is, in fact, nothing in it but a hard-and-fast, inelastic, inflexible, and mechanical operation of a system working from a centre, and based upon the assumption that men are mere things to be wound up, like pieces of mechanism.

In conclusion let me say that I am opposed to any method, no matter how successful in production of goods, which works out in undue regimentation of specialised labour. Recent observation in America convinced me that specialisation has there proceeded far enough, if not too far, already. It is robbing the workshops of mechanics and filling them with men whose daily life precludes the possibility of developed individuality. For, after all, men are to a large extent made or marred by the circumstances of their daily life, and no system or method can be truly successful which fails to take cognisance of that fact.

Methods of remuneration and workshop management generally should aim at protecting and encouraging the weak, curbing the morally unscrupulous, and leaving the average man room to live and grow—in other words, should give all men share in the extra advantages as well as extra labour incidental to intensified forms of production, and thus harmonise individual with collective well-being.

The Editors of course allow Mr. Barnes free expression of his views concerning all systems of wage payment. They hope in a succeeding number to give Mr. Gantt's own exposition of his conception of the remuneration of labor.



PART OF THE LUDWIG LOEWE & CO. WORKS, BERLIN. ONE OF THE NEWEST AND LARGEST GERMAN MACHINE-TOOL BUILDING ESTABLISHMENTS.

The upper picture shows the light planing department; the lower, the turning department. The floors, lighting, adjustable shaft-hanger system, and industrial railway are particularly to be noted.

WORKS DESIGN AS A FACTOR IN MANUFACTURING ECONOMY.

By Henry Hess.

Works management logically should begin with the direction of the first design for the plant, and it is from this point of view, with the concrete example of a design which was actually carried out, that Mr. Hess discusses the topic. The manager may not often have had equal opportunity to arrange his works, but he may yet find much of interest in the study of ideals toward which gradual rearrangement or radical reorganization may proceed. The illustrations represent both types of shop—those designed new to occupy wholly new sites, and those which by success have far outgrown their original bounds and have been readapted to cope with the demands of the new conditions.—The Editors.

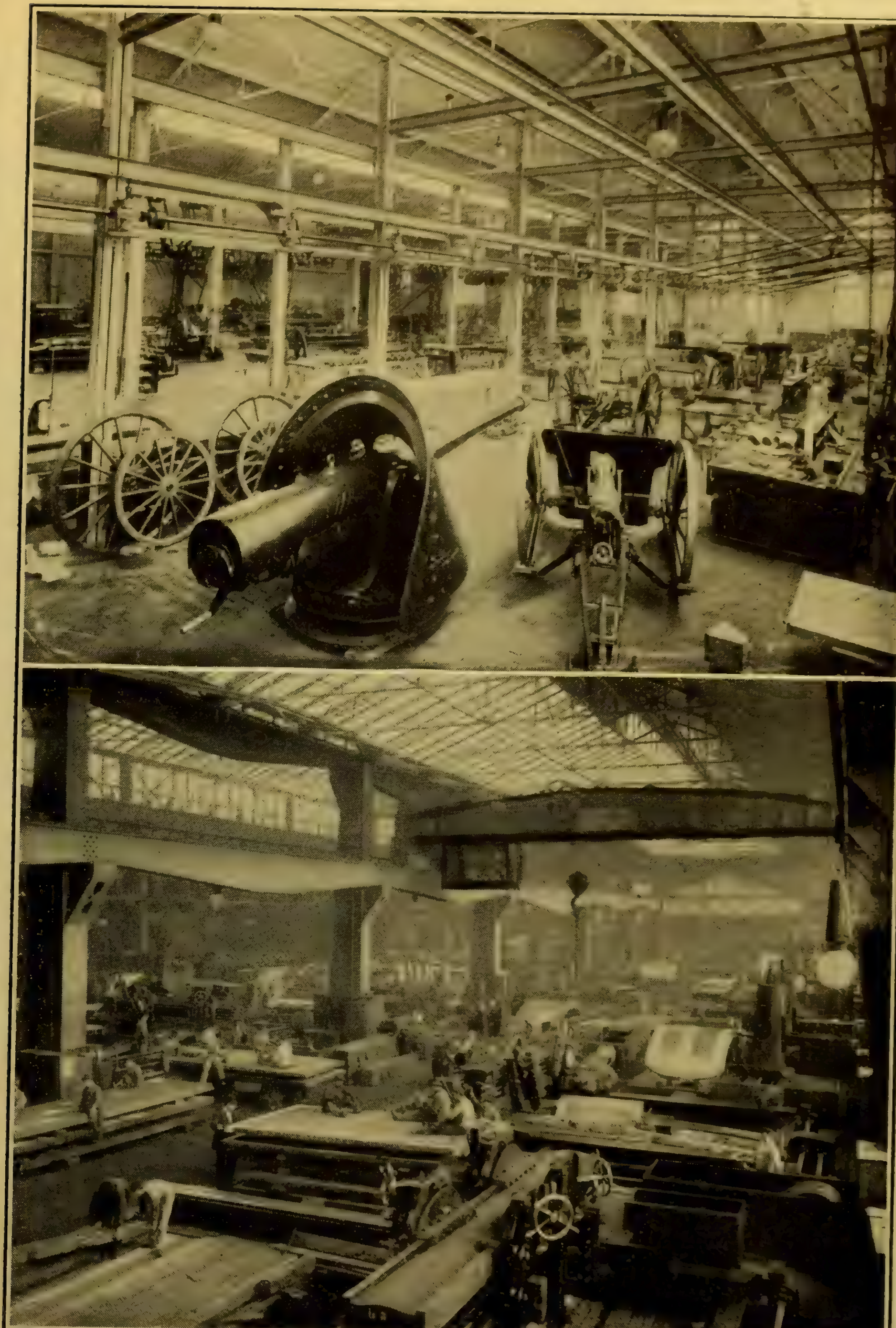
WORKS design includes broadly all elements that enter into the planning of a works up to the point of starting the machinery on actual manufacturing. As the term "works" itself may be made to include plants for producing on a large scale every article made for the use of man or beast, it is to be understood at the outset that though much that is said below will apply even in this broad sense, machine-building works are referred to more specifically. The various mainheads are referred to in the order in which they naturally come up for consideration.

The Site.—It is not always—in fact, it is rarely—that this can be selected solely with a view to its complete adaptability to the branch of manufacture in question; yet it is vital that it should at least approximately correspond to the needs of the special case. In general, it may be said that the more largely material enters as a factor of cost compared with labor, the more vital will correct choice of the site be. An ideal site will be level, will have a sandy clay soil over a subsoil of gravel and clay, will be located directly beside railway or waterways or both, and will have good trucking roads. Once in a way a site may be found with all these desiderata and at a reasonable cost, but not often. Falling short in one particular or another, it will become the duty of the designer to consider carefully the relative costs of site, of shipment, of foundations, etc., in making a choice. First cost should weigh less than items that will cause continually recurring expenses; should the available means not be sufficient, then increased running costs must be accepted as an unavoidable handicap. Adequate railway shipping facilities will, as a rule, be more important than convenience of shipment by water; railways are available the year round, and will also average less trans-shipment en route both for raw material and product. If the chief item of cost in manufacture is labor and the product not too bulky or heavy, then good trucking roads to a railroad and a cheap site will be preferable to direct railway conveniences and a costly site.

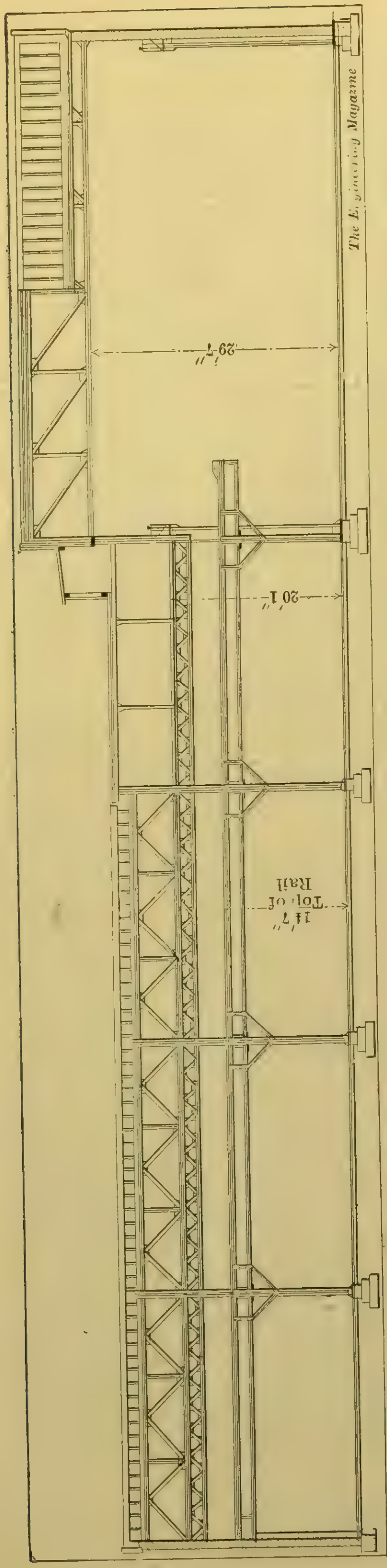
In selecting the site due regard should be paid to the labor element. There must be an assurance that labor will be not only abundant, but also of the right quality. Vicinity to large cities is not advisable; the city itself will always offer inducements that will make work in the city preferable, so that the works outside will get only the flotsam and jetsam. A site in the city itself will generally be too costly for all but light manufacturing. A site at a considerable distance will have an initial disadvantage in procuring labor, but once procured it is apt to be steady; such location may bring about the necessity of investing capital in workmens' dwellings; that need not be a deterrent, and certainly not a handicap on the manufacturing economy, since such investment can readily be made to bring a fair return. It should, however, be considered a separate investment. Indirectly, the steadiness of reliable labor will tend to manufacturing economy.

Ground Plan and Elevation.—Having determined on the site, the general ground plan must be worked up. That this should be laid out so as to ensure a steady forward progression from point of receipt of raw material to shipment of finished product, is today so well understood that the statement has all the air of a trite commonplace. For all that, it is not infrequently sinned against. Then comes the question of advisability of one or more floors. For heavy work there can be but one voice as to the desirability of ground-floor shops, possibly with galleries for some of the lighter work. For medium work the cost of ground-floor space will govern the selection. For light work several floors will be preferable; aside from the advantage of smaller capital investment in real estate, the cost of transportation of work in progress will be less from floor to floor, than over the necessarily greater distances of single-floor shops; it is assumed that ample elevator facilities are provided. This presupposes also that the width of shop and location with reference to its surroundings will allow getting light in generous amount to the middle; unless this is the case, single-floor construction is preferable.

The work to be performed must now be analyzed as to its main stages. The buildings should be so arranged that the first operations can be carried on as close to the point of receipt of raw material as



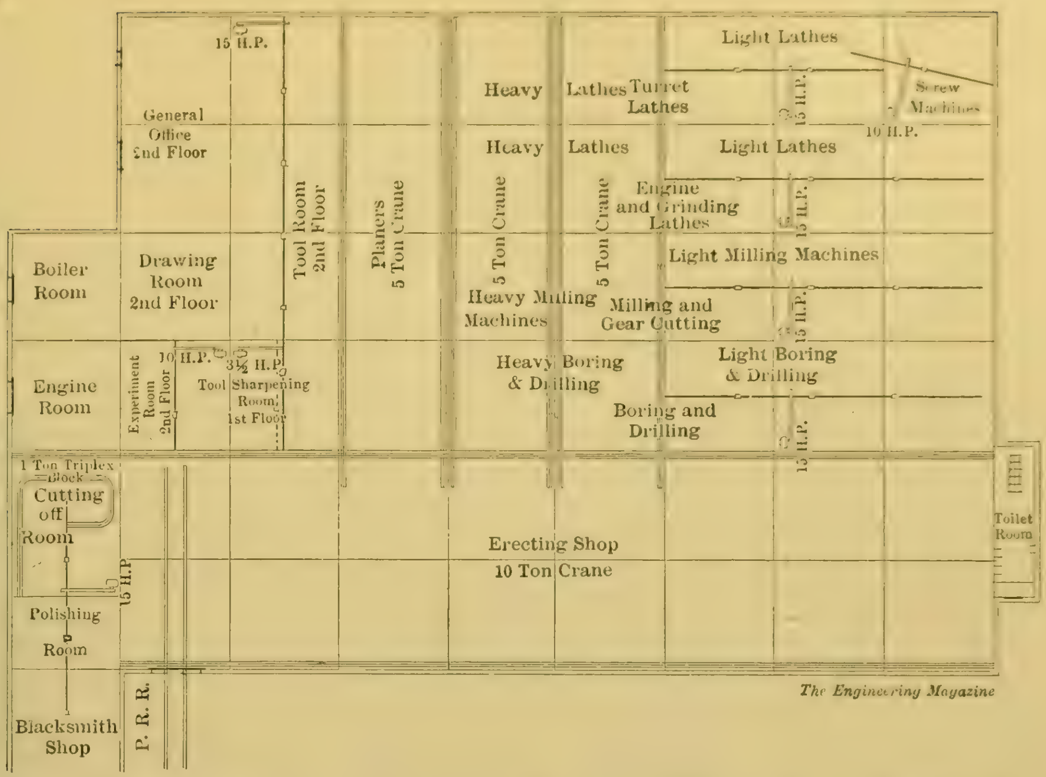
THE UPPER PICTURE SHOWS THE NEW GUN SHOP IN THE WORKS OF THE JOHN COCKERILL CO., SERAING, BELGIUM. THE LOWER IS TAKEN IN THE ARMOR-PLATE DEPARTMENT OF THE GREAT KRUPP WORKS AT ESSEN, GERMANY.



SECTION ACROSS MACHINE SHOP AND ERECTING SHOP, NEW WORKS OF THE AMERICAN TURRET LATHE CO., WARREN, PA.

is practicable, and the last operations similarly near the point of shipment, or of storage awaiting shipment. Operations that from noise, smoke, or other nuisance would hinder other work, should be carried on in separate buildings, or in sections suitably partitioned off. If the work does not have to pass the various departments one after another, but consists chiefly of details coming together for final assembly, the various departments should be suitably grouped near the assembly department and all at practically the same distance from it. The same consideration holds for semi-finished products that represent an aggregation of operations. The two methods of advancing the work from raw material to finished product may be likened to "series" and "parallel" work in electric wiring, with a combination of the two analogous to "compounding."

Height will have to be governed by the necessities of the product, and considerations of lighting, heating and ventilation. Great height is generally called for only in erecting departments for large machinery. Other departments, however, should not be stinted in this respect, as otherwise a good distribution of natural and artificial light, equable heating, and good ventilation, are difficult of attainment. Where cranes are needed these should be given plenty of headroom, and the floor plan and distribution of machinery so arranged that a minimum number of cranes may be widely distributed, or again concentrated,



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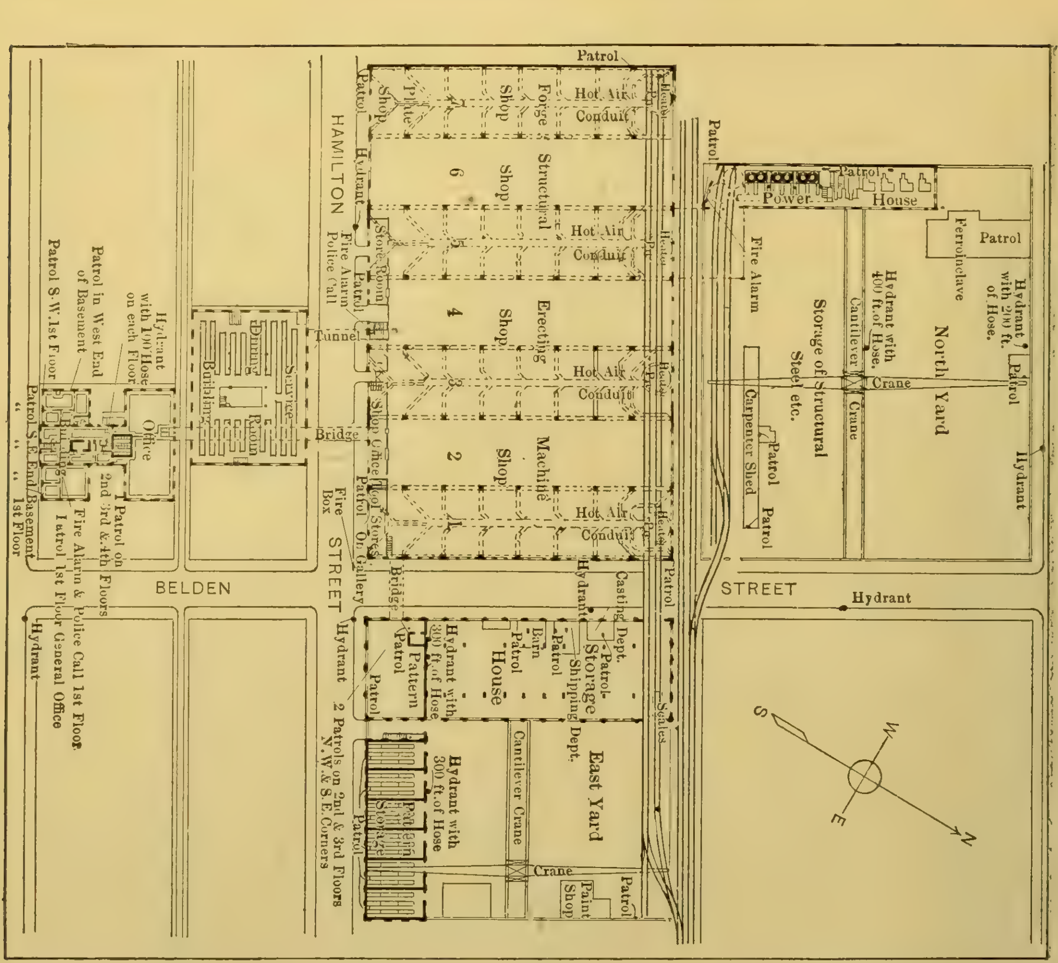
GENERAL GROUND PLAN OF NEW WORKS, AMERICAN TURRET LATHE CO., WARREN, PA.
The planer department and the two adjacent departments, at right angles with the erecting floor, are covered by 5-ton cranes. The smaller tools, under a lower roof, are at right angles with the planer section and parallel to the erecting floor. Each lineshaft is driven by an independent motor; the larger tools under the traveling cranes are individually driven. In the screw-machine section, as will be seen, the shaft is set at an angle.

with the varying demands made on their service. It is always advisable to design for a very much larger plant than it is intended to build, and so to arrange ground plan and elevation that subsequent enlargement and rearrangement of the machinery is not hindered by the building itself. That means that the building should be an assemblage of similar units, and not be composed of units each adapted specifically to the machinery it is to contain at the outset. If this is done, subsequent enlargement and consequent shifting of tools to maintain the original steadily forward progression of the work can be had with a view solely to economy of manufacture. It will also be found that buildings laid down along these lines will not be a hindrance later to taking up a new line of manufacture.

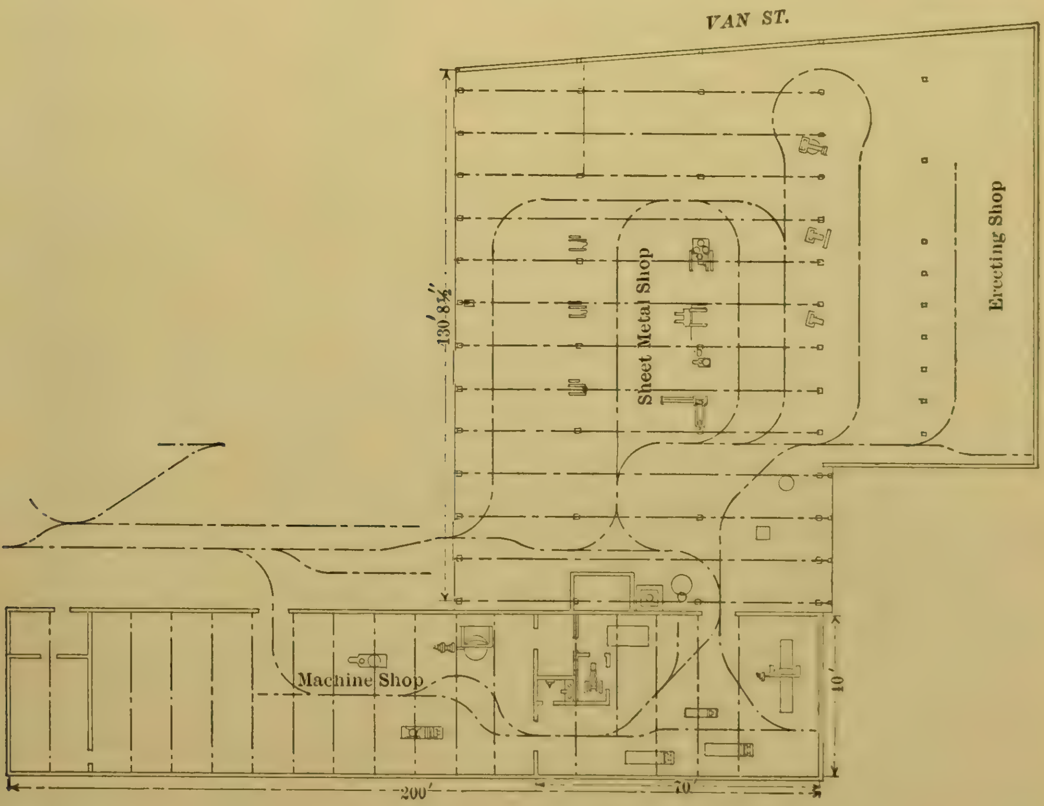
Power Plant.—This will be governed largely by the available source of power, whether coal, gas, or water; electricity will as a rule enter only in competition with shafting as a distributing agent. Usually the location of the plant will govern the relative cost of power, and with that the choice. The conflicting claims of shafting and electricity



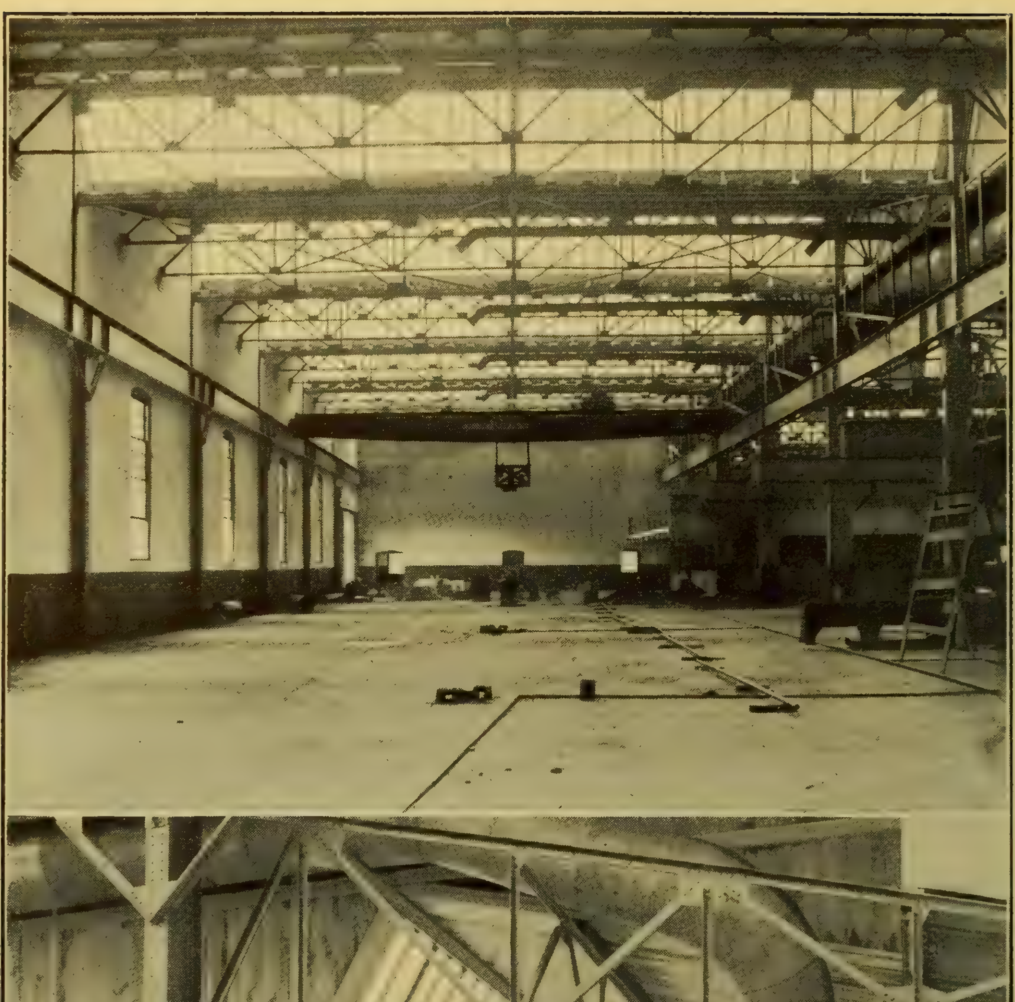
GENERAL GROUND PLAN OF THE SHOPS OF THE BROWN HOISTING MACHINERY CO., CLEVELAND, OHIO.

for distributing the power will have to be carefully considered; not only first cost of installation, but also subsequent convenience and indirect influence on economy of production should govern the choice. It may be said that for most lines of manufacture in which the individual machines do not require more than 10 horse power, distribution by electric current rather than main lines of shafting will be ultimately the most economical. In sections of the country that call for much more will be found to promote economy, particularly so when the larger machines have to be forced and worked over time; that will often be the case in machine-building industries, since the heavier tools are so costly that the equipment is very likely to fall somewhat short of a complement full enough to balance the output of the smaller tools in the same working time. Properly designed individual driving will also conduce to working economy, as the greater handiness of speed changing will induce the workman to make use of its possibilities and so save time and increase his output. Smaller machines will be best grouped in units of from 10 to 25 horse power. If, owing to high cost of floor space, it is advisable to crowd machines together, individual direct motor drive of even the smallest tools will permit going farther in this direction than group driving. The first cost, with careful adaptation of the building itself to this method of power distribution, will vary so little that mainly questions of continuous running costs should govern the choice; as a rule these will be less when machines are not too closely crowded.

Lighting.—Abundant light, properly distributed to avoid cross lighting, glare, and heavy shadows, is an element of economy not easily over-estimated. To get in plenty of daylight cannot be said to be expensive or even more costly than to build without this in view. There are many well known types of single-floor construction to select from to suit the needs of any particular case. For low or medium high shops the English sawtooth is very good indeed; for medium and high shops, particularly if they are fitted with craneways, the central monitor with vertical sidelights is good; this type is most generally used in the United States; better still is a form used in Germany; this is clearly shown in the sectional diagram on page 514; the roof rises to



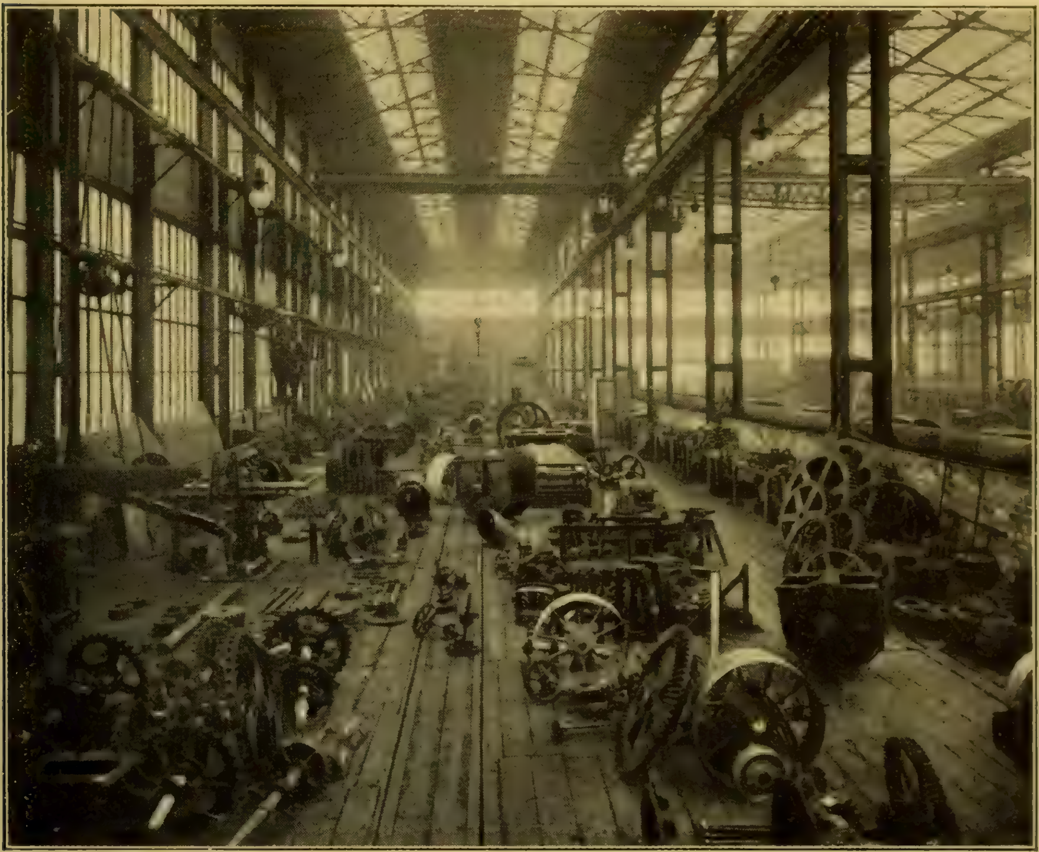
OUTLINE PLAN OF MACHINE, SHEET-METAL, AND ERECTING SHOPS, THE C. W. HUNT CO., WEST NEW BRIGHTON, STATEN ISLAND, N. Y.



TWO VIEWS OF THE AMERICAN TURRET-LATHE CO.'S NEW SHOPS, WARREN, PA.

The upper is the erecting shop, in which the saw-tooth roof is a novel feature. The features of lighting, heating and ventilation, crane service, and relation of machine shop to erecting departments are noteworthy.

the ridge in two pitches; the outer flat pitch is dark, the central steeper pitch is of glass. A reversal of this arrangement has the flatter dark portion next the ridge, which is then joined to the walls by the steeper pitched glass sides. Both forms are equally good as regards giving light to the interior, but the second form is not suitable for shops built in aisles; it will then not let in as much light, and be difficult to keep free of snow in the sharp deep gulley found at the junction of two aisles. The form illustrated has been found to be practically self-clearing of snow though the agency of ordinary winds aided by the interior warmth of the shop. The material of the skylights is of the utmost importance; it should permit the passage of as great an amount of light as possible and yet prevent all glare; that means finely ribbed or ground glass, preferably of a yellow tint rather than green or white; in default of that the glass should be lightly coated with thin grey paint—not lime wash, as that flakes and is ultimately more expensive from necessity of frequent renewal. For all but vertical skylights, wire-glass should be employed. Some flexible substitute for glass would be very good; I believe that there is such a substitute which

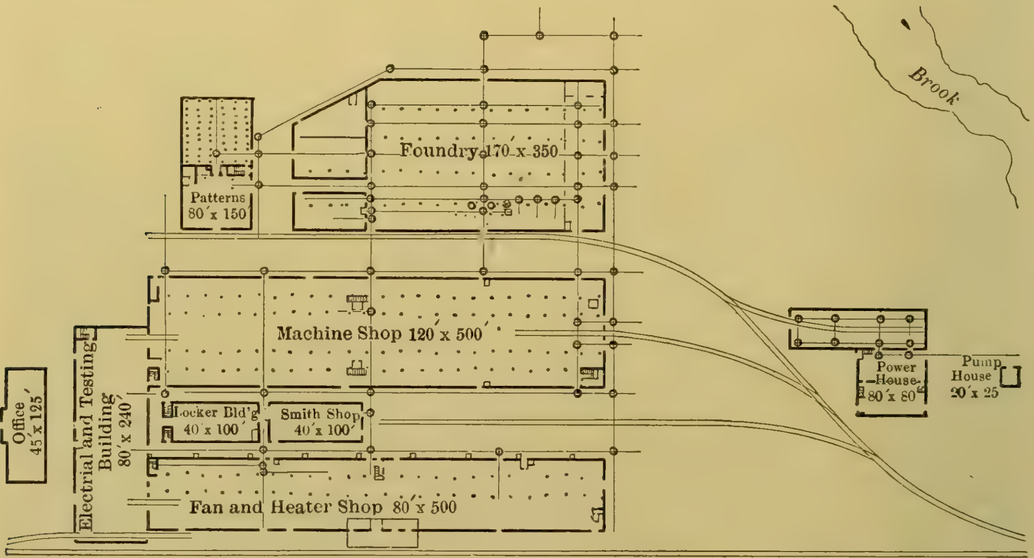


MACHINE SHOP IN THE NEW WORKS OF MESSRS. GRAHAM, MORTON & CO.

Showing craneways, industrial railway, and lighting arrangements.

has been used with very good results, but cannot speak from personal experience.

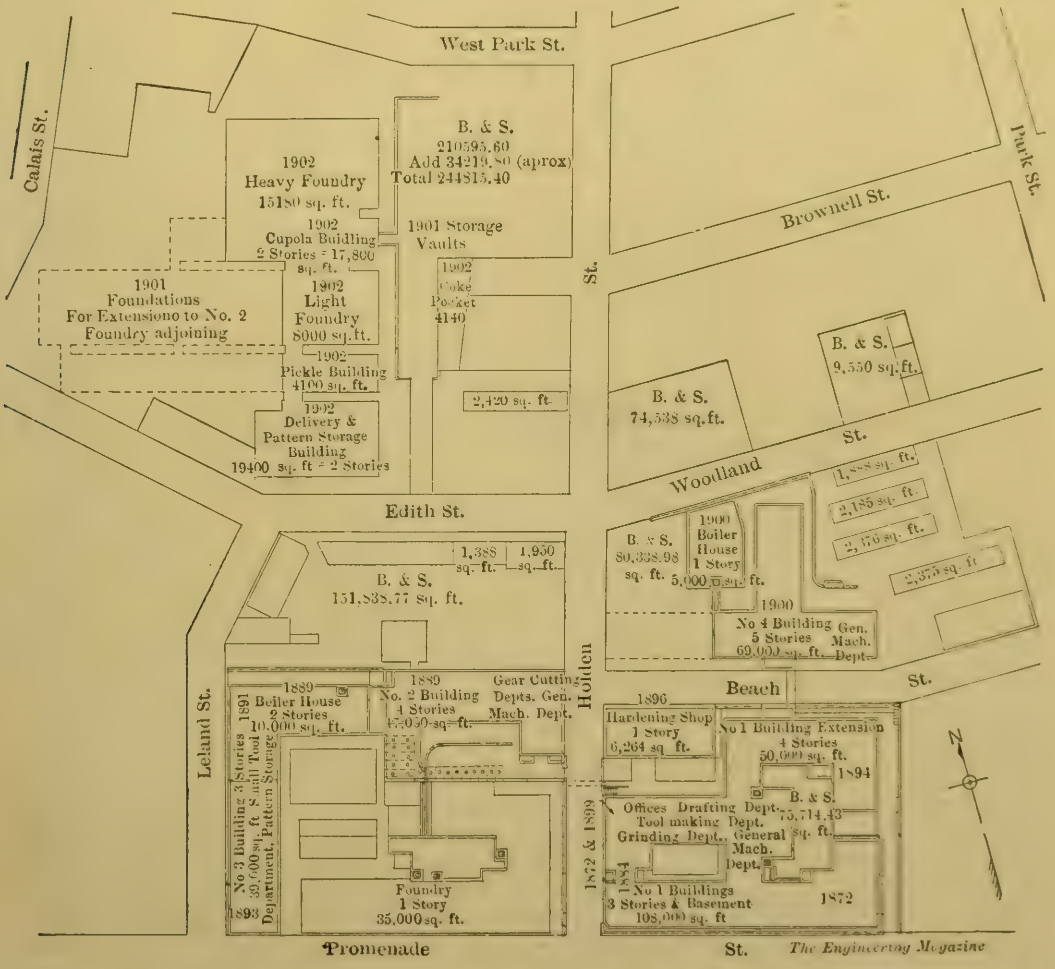
The importance of adequate lighting at night is an element of manufacturing economy only secondary to that of day lighting. The electric light is practically the only one to be considered. Arc lamps for general illumination will cost least; they should be so hung as to give an even distribution without heavy shadow anywhere. It will be best to determine their location experimentally after all the other shop equipment that reaches over fifteen feet from the floor is in place. On the whole, they are best hung fairly high, so as to be above the ordinary upward glancing line of vision of workmen even at some distance; if that is done, and the amount provided is liberal, very much less secondary lighting by less efficient incandescent lamps will be needed; usually a portable hand lamp with convenient bracket will then answer for most machines.



The Engineering Magazine

OUTLINE PLAN SHOWING ARRANGEMENT OF NEW SHOPS OF THE B. F. STURTEVANT CO., JAMAICA PLAIN, MASS.

Heating and Ventilation.—These two matters must be treated jointly as they affect one another; both are important elements of the cost of production as they seriously concern the comfort and well being of the workmen and therefore indirectly their working capacity. For large open shops moderately warmed air, forced into the shop near the roof at moderate speeds and pressures and in sufficient volume to renew the air about three times an hour, is best; this need not be more expensive of installation than any other system. In the United States this method is very well known and considered standard, but in England and Europe it is little known and meets with much opposition. In Germany heating by forcing in hot air has been tried, but failed; the air was greatly heated, and then forced in in too small volume; the mistake made was in attempting to heat the large body of shop air by the addition of a small body of relatively hot air, instead of supplying the entire volume of air in renewal and moderately warmed. For low or small rooms a similar system can be economically employed, but must be much more carefully designed to secure even distribution and avoid enervating blasts of warm air. The plant should be of sufficient size to secure a shop temperature of about 55 degrees F. with the average outside winter temperature when taking all of the air from outside. For exceptionally cold weather it will then answer to use part of the shop air over again. Ventilation is to be secured by arranging openings in the apex of the roof or at the sides of the monitor; it will be best to arrange for closing these during very



The Engineering Magazine

GENERAL PLAN OF THE SHOPS OF THE BROWN & SHARPE MFG. CO., PROVIDENCE, R. I.

An example of successful growth and extension amid a rather contracted environment, under the impulse of a rapidly increasing business.

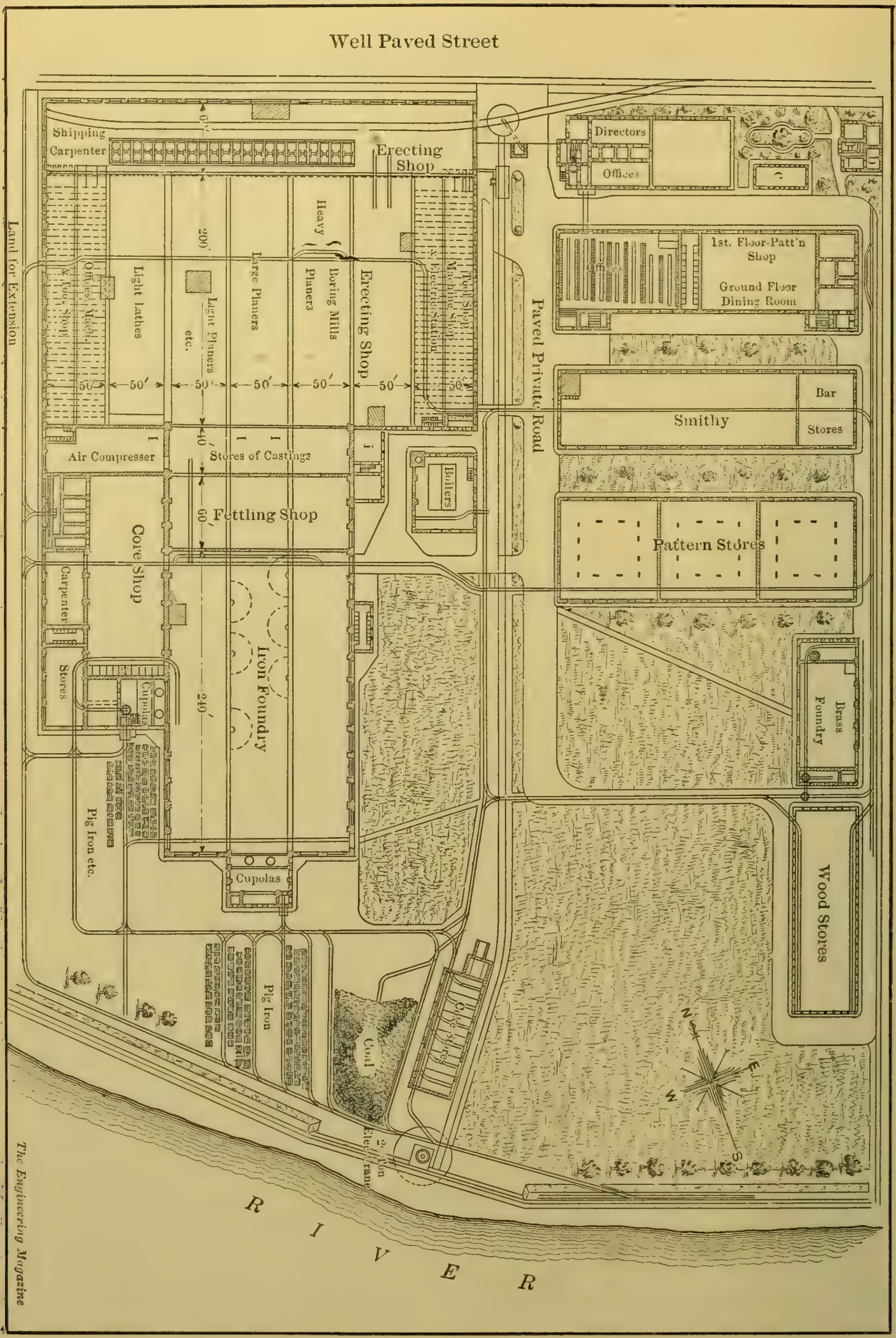
BRASS MACHINE SHOP AND A PART OF THE GENERAL MACHINE SHOP IN THE BALDWIN LOCOMOTIVE WORKS, PHILA., PA.

cold weather. In warm weather the air can be kept moving by the fans of the heating plant just described; this can be usefully employed further to actually cool the air during very hot weather by drawing it over the winter heating coil, which is then supplied with cold water instead of steam. The side windows should not be depended upon for ventilation, unless they are placed very high. Within reason, height of shop will conduce to better ventilation as well as to more even distribution of warmth and light.

Heating of smaller shops by direct steam piping may also be well done, and will usually involve less initial outlay than hot-air heating as described; it can not, however, give as good results in providing an atmosphere most favorable to the employees' working ability as the hot-air method at its best, and is therefore less to be recommended if maximum running economy is aimed at.

Sanitary Arrangements.—Washing facilities should be ample and coupled with a place for cleanly storage of clothes; this will indirectly affect manufacturing economy through its influence on the self respect of the workers. Luxury is not called for—is in fact out of place. Closets should be conveniently located to the place of work, to avoid loss of time; they should not be located in dark corners inviting a quiet occasional loaf and smoke. The question of sewage disposal can be settled only in accordance with local conditions.

Machinery Arrangement.—The location of each and every machine should be carefully determined beforehand and not left to the happy inspiration of the moment when the tools begin to come in. There are two broad points of view governing choice of location. Either a full complement of tools is to be provided for each separate product, corresponding to the idea of individual shops, having only a central purchasing and selling department and head manager, or the machines are to be purchased and grouped solely with an eye to the performance of analogous operations in departments specially designed. The first method calls for a larger initial outlay for plant, and will also require rather more foremen; with it there is less liability of disturbance in final erecting from an operation or part having been forgotten or not finished in time. The second method has the possibility of finer cutting down of time and cost of performing the various detail operations, and requires less foremen and a smaller number of tools, which latter can also be more concentrated. If its possibilities are to be fully developed, it must be given a highly competent rate-fixing staff. The drawing room also must restrict itself carefully to the use of standard forms; this is not by any means easy



The Engineering Magazine

GENERAL GROUND PLAN OF THE DEUTSCHE NILES-WERKZEUGMASCHINEN-FABRIK, BERLIN.

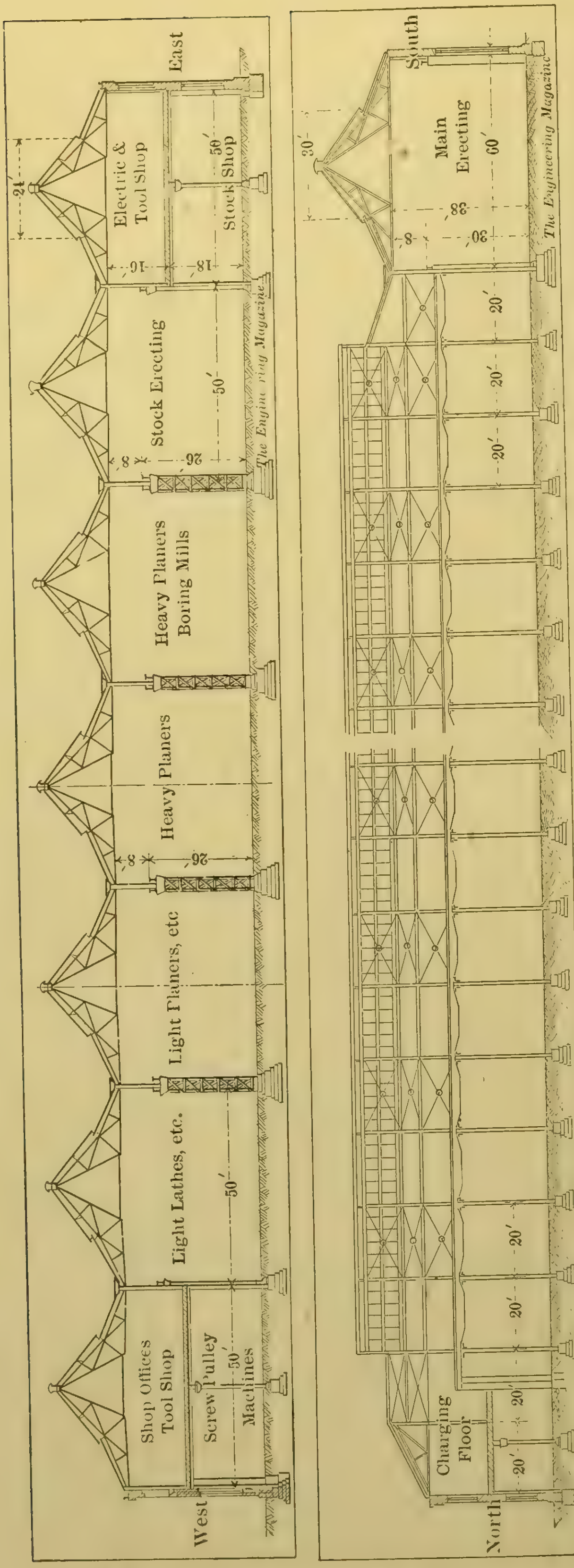
of attainment even in the United States, where standards and labor saving are in the air. Where part of the product is likely to be built in relatively larger numbers, and part only a machine at a time, it is advisable to create separate departments for these two classes. Certain special work, such as gear cutting, is best taken care of in a special department that delivers to the others. Heavy machines should not be duplicated in the two departments, unless there is enough work in each to keep each set fully employed.

Foremen, clerks and others having to do directly with the shop work should have conveniently located offices as central as possible to their work; these offices should be partitioned off for the sake of cleanliness and occasional privacy; the original design should include an equipment for accessible filing of all pertinent data; more than mere mention of such equipment is not pertinent to the subject now under consideration, but comes under the head of works management and system.

General Stores, etc.—For a large works it is best to have a receiving store department conveniently located with reference to the point of receipt of goods and their distribution; subsidiary or distributing storerooms, which may often be conveniently coupled with tool rooms, should then be located as centrally as possible in each department. For a smaller works a combined receiving and distributing store, centrally located, will be best. Central location does not necessarily refer to the geometrical centre, but rather to convenience to the natural avenues of travel of men and goods.

A plant designed by the author for the building of medium and heavy-weight machine tools may serve as an application of the principles laid down. The ground plan is shown on the opposite page.

The works was intended, as just stated, for the building of medium and heavy-weight machine tools. The parties financing the venture decided to put up a plant having a capacity sufficient to employ about 1,200 men to start with, and to be independent of outside foundries, etc. They also wished to have more than usual attention paid to general appearances, and to such matters as arrangements for workmen's conveniences and comfort, even at enhanced cost. They had selected a site in a small but growing manufacturing community within ten or fifteen minutes of a very large city, by frequent railway connections. This site had river frontage, the well paved main street of the town with a railway track on the opposite front, and a paved road connecting the street with the river front along one side. While somewhat costly, this was not considered an obstacle, as values had



CROSS SECTION THROUGH MACHINE SHOP AND LONGITUDINAL SECTION THROUGH MACHINE SHOP AND FOUNDRY, DEUTSCHE NILES-WERKZEUGMASCHINEN-FABRIK.

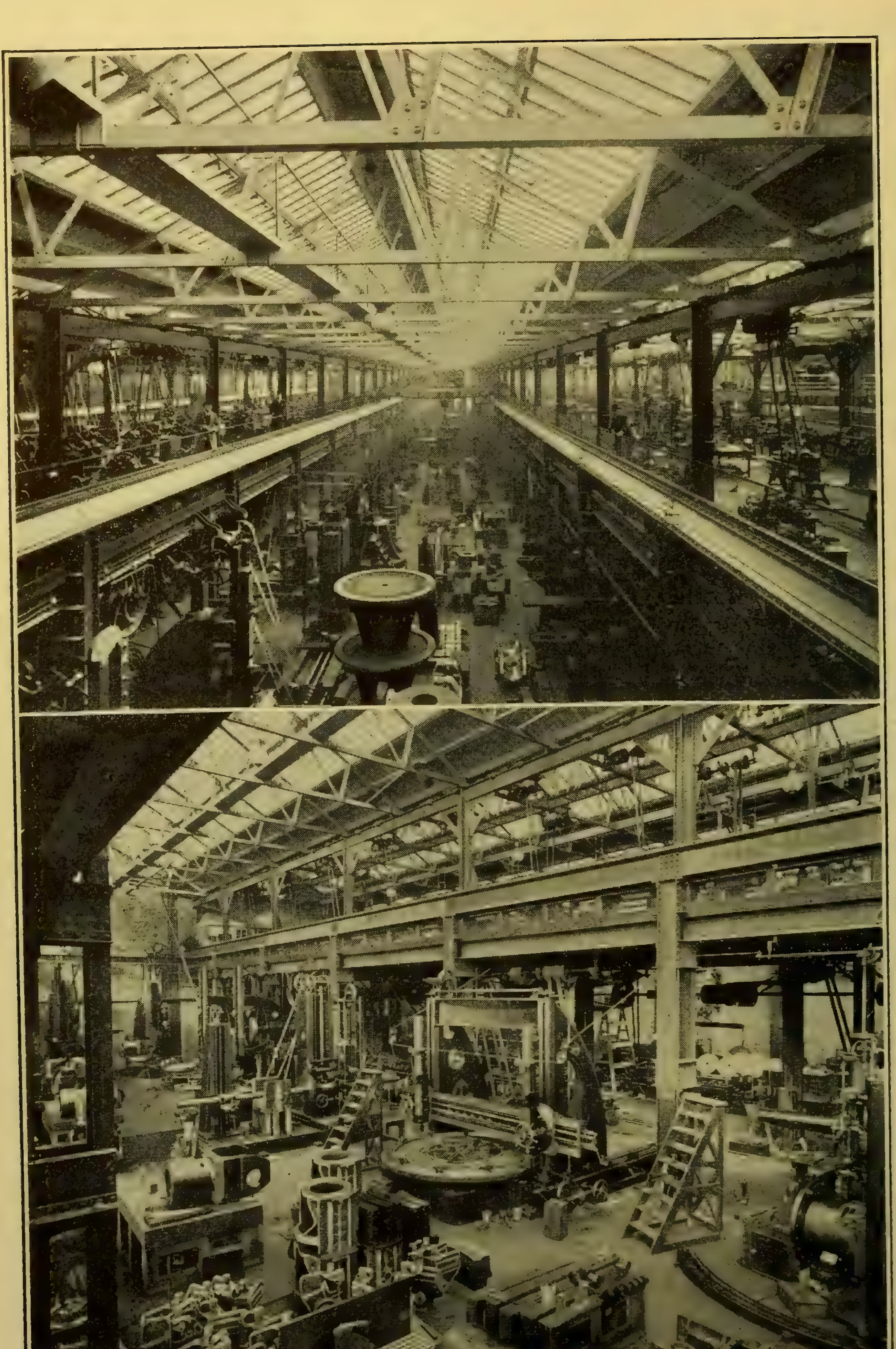
been regularly increasing and were sure to keep on doing so.

This was the condition when the designer was called in.

Careful borings showed that the soil was in general of a good reliable character for even heavy buildings and called for little piling; there was a top layer of rather loose sand, so that all free spaces were later sown in grass to bind this. Trees were allowed to remain as far as possible. A mill on the other side of the river had the right to build a bridge, and with that a street approach; this compelled laying out the paved private road about 500 feet from one side of the boundary, and also determined the placing of all of the subsidiary buildings on the narrower plot so divided off, and of the main shops on the other. As rough stores, such as pig iron, coke, coal, etc., were, during the open season at least, most cheaply brought in by water, the shop for first operations—i. e., the foundry—was placed toward the water front. Storage was therefore also provided there, ample enough to permit purchase during the open season sufficient to carry the works through the winter and save the higher railway freights. A full-gauge railroad track was carried down the dividing street to make the storage spaces accessible also by rail. The covered coke sheds were placed alongside this track. The main shipment of finished machinery was to be by rail. This brought the erecting shop nearest to the main-street front with its track; a siding was laid directly through the erecting shop, which was therefore also placed parallel to the main street. The machine shops were all placed at right angles to the erecting shop.

A casting-storage room was placed at right angles across these and between them and the cleaning room of the foundry, which was placed parallel to the storage room. The foundry was arranged beyond the cleaning and storage rooms practically as a continuation of the machine shops. The main cupola was located at the lower end of the foundry; a lighter cupola was placed at about the centre of the foundry on the western side. The charging floors were made commodious enough to accumulate material for two days heat; a second cupola beside each of the original ones was provided for.

A study of the plan will now show that pig and coke were received at the lower end of the foundry, molten metal was carried forward lengthwise, and rough castings were carried forward along any one of three foundry aisles to the cleaning room terminating these aisles. From the cleaning room they were carried directly into the store room, or beyond this into the lengthwise aisles of the machine shop, and from these to the erecting bay in which all of the shop aisles terminate. In those shop aisles in line with the foundry aisles the heavy machinery was placed, so that heavy castings were carried forward only in straight lines, from casting to erection. Craneways were laid continuously through shop and foundry aisles over the intermediate storage and cleaning rooms. This reduced handling to the utmost limit, and also permitted the use of a smaller number of cranes. At casting time the shop cranes could help out the foundry, while at other times the foundry cranes could help out the machine shop. Dirt was excluded from the machine shops by a system of sliding and rising partitions. An exhaust fan in each skylight was also planned in case the partitions should prove insufficient. Actual experience has proven that the rather costly partitions could have been omitted; with the given conditions of shop height and roof construction and ventilation,

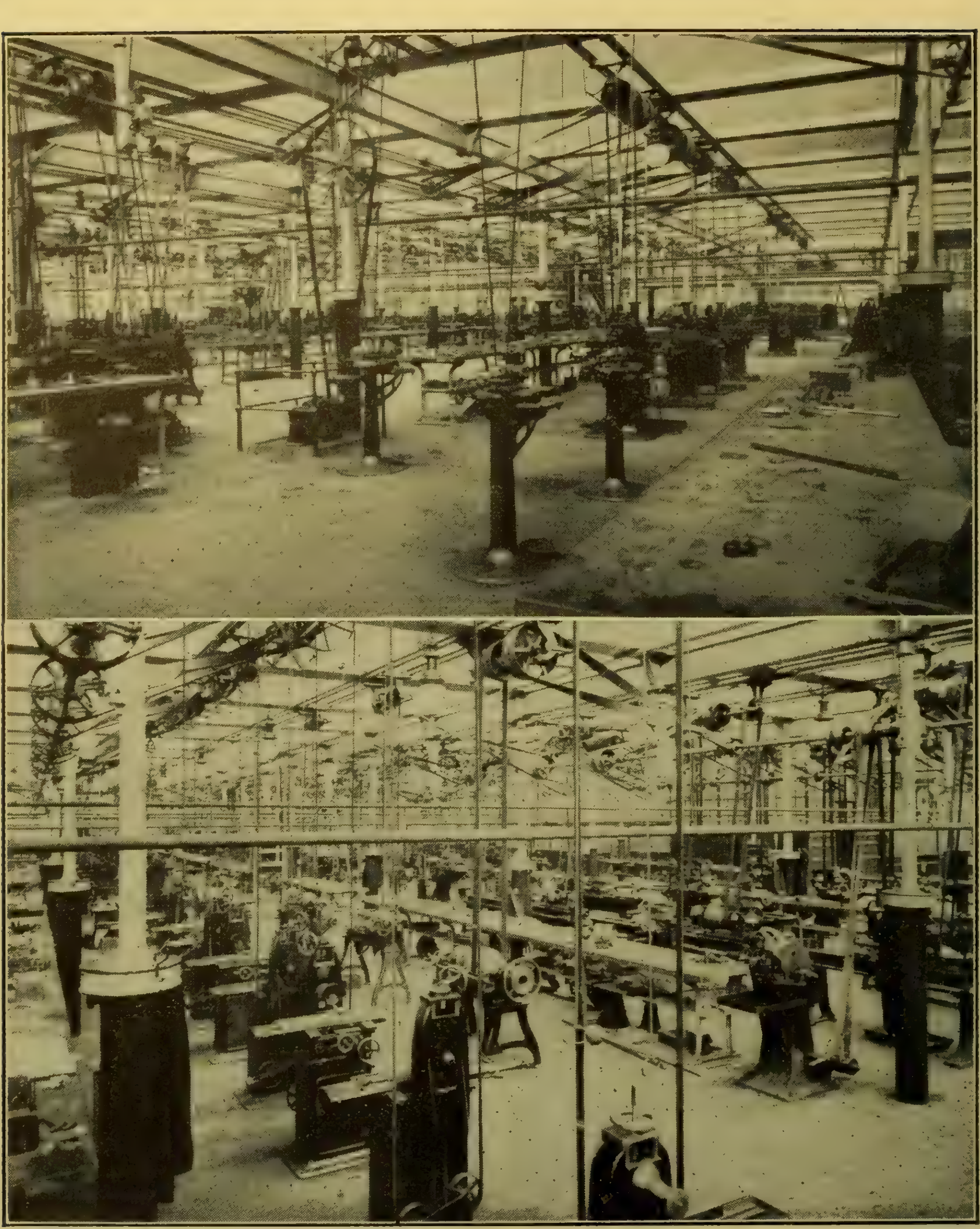


GUN-MOUNTING DEPARTMENT (ABOVE) AND CARRIAGE DEPARTMENT (BELOW) IN THE ERITH WORKS OF MESSRS. VICKERS SONS & MAXIM, LTD.

exhaust fans in the skylights would have been all sufficient even without running all the time.

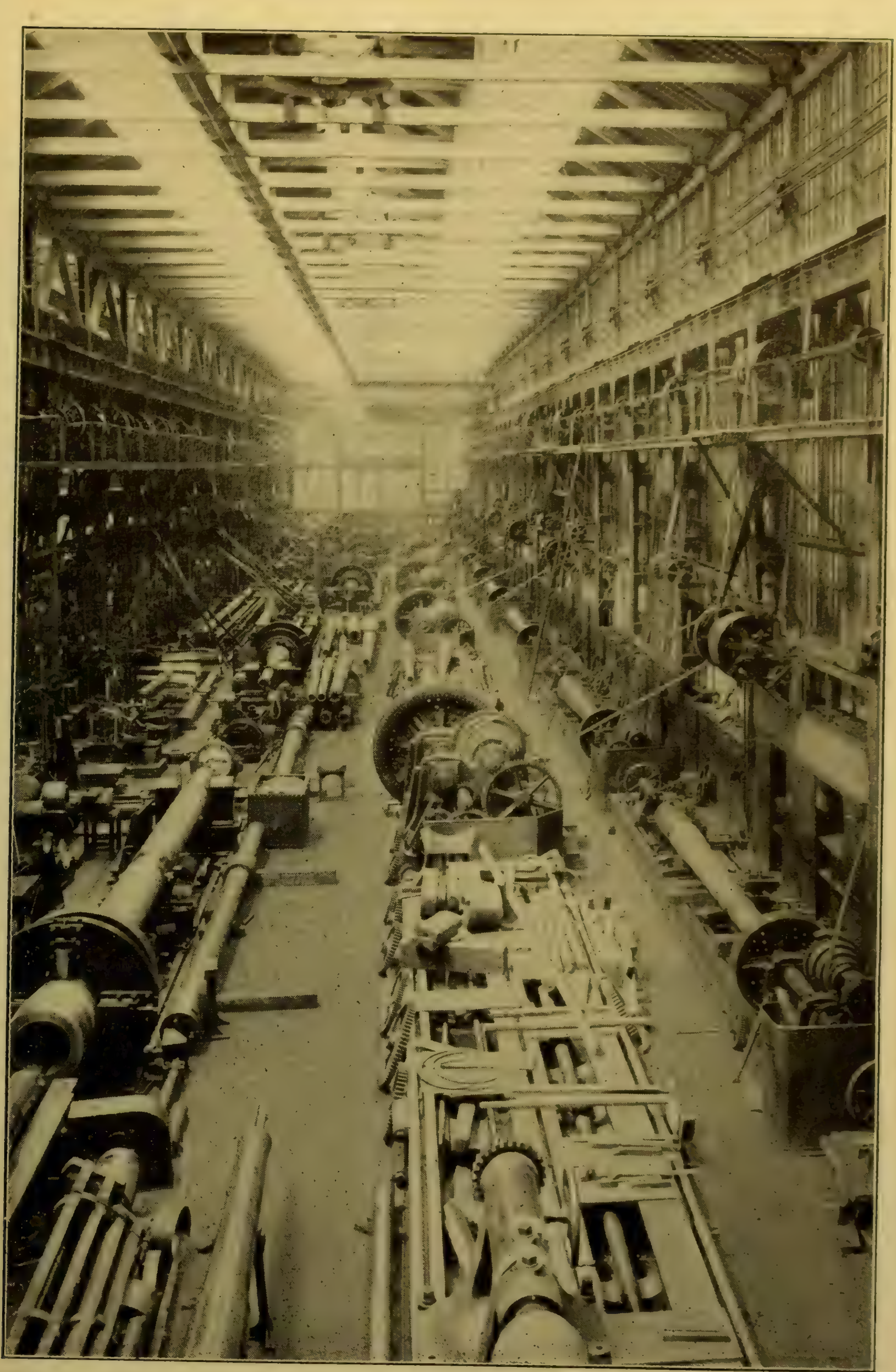
Lighter machine work was performed in other aisles paralleling those for the heavy work. The last aisle of each side was provided with a gallery of the full width of the aisle. The two aisles to the east were set aside for the building of certain machines in larger lots; the second aisle was intended mainly for erection.

The tool-making shop for this department was placed on the gallery. The balance of the gallery was given up to the various switchboards, etc., of the electric plant. In the east aisle were placed also the general milling and gear-cutting machines as a separate department, serving both divisions of manufacture. All the rest of the shop was given up to the building of machines in single lots. This latter department also had its own separate tool-making room on the west gallery. Here also were placed an office for the engineer who looked after shop methods and designed shop tools, etc. All the parallel aisles, whether in shop or foundry, had exactly the same cross section and roof construction; extension was planned for by adding parallel aisles on the west side; columns and crane girders were built into these walls so that no disturbance would be created by such extension. The first extension of the foundry would be one or two aisles to the east, and after that as many as might be called for to the west. The subsidiary foundry departments, such as core rooms, ovens, small stores, etc., were housed in lower buildings of less costly character to the west; they were therefore close to the actual moulding floor, and would later not be expensive of renewal. First extension through to the east would give an increase of foundry floor of two-thirds, so that the probability of renewal of these buildings was too remote to weigh against the advantage of immediate proximity. A room for housing an air compressor dovetailed nicely between core room and machine shop. A power plant was not put down, but power derived at reasonable rates from a neighboring generating station controlled by capital interested in the shops also. A small boiler house of relatively inexpensive character was put up in the eastern angle between shop and foundry to supply steam for the heating plant during the winter. Four air-heating and distributing units were placed at I, I, I, and I; the two central ones over the casting store in the roof, another in the compressor room, and the last in a small annex to the east that also housed a paint and saddlery shop and foundry offices. These heating plants were thus centrally located with reference to the machine shops and foundry and also close to the steam-generating plant.



MILLING AND TOOL-MAKING DEPARTMENTS OF THE LINOTYPE COMPANY'S WORKS, BROADHEATH, MANCHESTER, ENGLAND.

Of the subsidiary buildings, that for the offices was naturally placed next to the street. Then came a two-story building with general drawing room and pattern shop above, and the washrooms with canteen below. Next came the blacksmith shop; this was placed here so as to bring its entrance in line with the side entrance to the machine shops; the rear portion of the smith shop was lightly partitioned off and devoted to the storage of current material, such as bar steel, etc.; here also were located cutting-off saws, centering machines, and



ONE BAY IN THE ELSWICK WORKS OF MESSRS. W. & G. ARMSTRONG, WHITWORTH & CO., NEWCASTLE-UPON-TYNE.

These celebrated British ordnance and marine-construction works have been recently noted for some of the most advanced experiments with the new high-speed tool steels.

straightening press; all material was therefore delivered from the smith shop ready for the lathe. Owing to the absence of steam during the summer months and the presence of an air compressor for driving pneumatic drills, hoists, chippers, etc., compressed air was used also for the steam hammers. Direct measurement of power for compressing the air gave rather high costs; it is difficult to say in just how far its use tended to economy in saving labor; on the whole, the evidence is favorable when running approximately with a full force and less so under conditions of slack work.

Next comes the pattern store house; this was located with reference more to ready communication with the foundry than with the pattern shop, as demanded by the preponderance of relative traffic. This building was divided by fire walls and double sliding doors into three bays; the first one of these was employed as a general storeroom. It was assumed that with the need for taking in this bay for pattern storage there would also be a call for enlargement of the main shops; it was then intended to place the general stores in these. All of these subsidiary buildings were dimensioned very liberally for the rest of the plant, as the projectors of the enterprise thought enlargement likely to be required in a time that would not justify the extra cost of enlargement of originally smaller buildings, as compared with the interest on capital invested in building liberally at the outset. A brass foundry was placed convenient to the rear end of the pattern store house; finally a lumber shed with open cage sides was placed beyond this and parallel to a paved road running along the rear of all of these subsidiary buildings. A system of Hunt tracks provided for ready intercommunication in short straight lines among the various shops and stores. A liberal equipment of trucks of various patterns further helped cut down the cost of moving material about.

The height of buildings, arrangement of roofing, and skylight, were all found to be favorable to lighting, heating, and ventilation. Construction and other data can be gathered from the various sectional elevations given.

All elements tending to an increase or to undue height of fixed charges must be most carefully considered; this is particularly necessary where a market must first be found or a reputation earned. In such case the output will for some time to come in all probability be small, so that high fixed charges may readily stifle an otherwise very promising undertaking.

THE TOOL ROOM AND ITS FUNCTIONS IN COST-REDUCTION.

By John Ashford.

The tool equipment is the producing machinery of every machine-building and metal-working shop. The importance of keeping this equipment at the point of highest efficiency needs no demonstration, but the conception of an organized department devoted specifically and solely to that end is comparatively recent. Mr. Ashford's article following is the first part of a comprehensive treatment of the problem; the second portion, which will appear in our August number, will deal with "The Proper Tooling of Machine Tools."—The Editors.

PERHAPS it would be well, at the commencement of an article dealing with the tool room, to state clearly what is meant by such a branch of an engineering workshop, at least so far as this article is concerned. By the words "Tool Room" then, is meant that branch of a modern machine shop wherein all small tools, jigs, templates, measuring appliances, etc., are made, stored, and preserved in a satisfactory working condition.

The great aim of every works manager is to obtain rapid production at low cost, and the tool room is a most important factor in securing such a result. That such a department is a necessity in a modern engineering establishment, will not be doubted by any manager who has once had one in successful operation. Large works there are that have been raised into positions of prominence without the aid of a recognised tool department. No doubt this was possible, because the conditions then existing were different from those of to-day; for, in the days of the past, engines and machines were *engineered* into existence by the aid of general utility tools and much skillful fitting and erecting, whereas now they are *manufactured* by specialised rapid-production machinery with the help of accurate measuring appliances and assemblers.

The word "engineered" is here intended to imply a process of origination and building up, coupled with the making of some parts to suit others already made, perhaps, without the aid of templates and gauges and without consideration for interchangeability. On the other hand, the word "manufactured" is intended in this instance to mean the production of standardised parts in quantity, such parts being produced independently of other parts, by special machinery, accurately to gauge and with small error limits. When so manufacturing, accuracy of measurement is usually enforced by rigid inspection, so reducing the work of fitting and erecting to practically a process of assembling, and also, ensuring interchangeability.

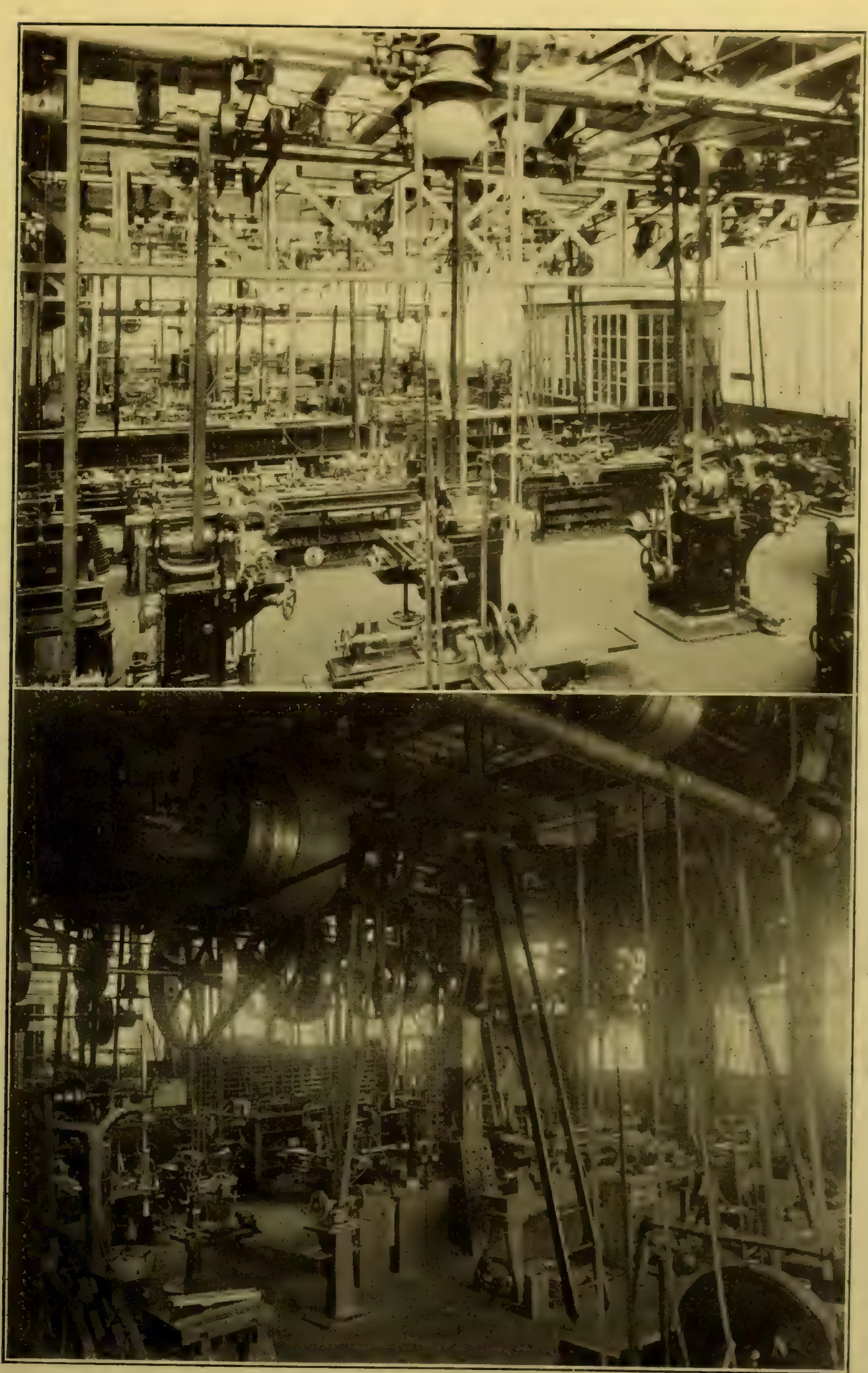
These two methods of production practically represent the conditions of the past and present. The general-utility machines, such as lathes, planers, slotters, and drills, were usually equipped with the simplest of tools, made by a smith and ground to shape by the machinist himself; and as limit gauges, micrometers, verniers, and jigs were almost unknown, the need for a tool room was not felt. Observe the difference in the modern shop that must have its limit gauges, twist drills, reamers for hand and machine use, the variety and assortment of turret-lathe tools, gang drills, form tools, jigs, and other special appliances and measuring instruments. These latter are all necessary to obtain the degree of accuracy requisite for perfect interchangeability, while using highly developed machine tools capable of doing given work in a fraction of the time hitherto possible.

Modern manufacturing methods must be adopted by all who desire to be in the front rank, and coupled with these methods there must be a modern tool room or its equivalent, otherwise high-class machine tools cannot be used to advantage.

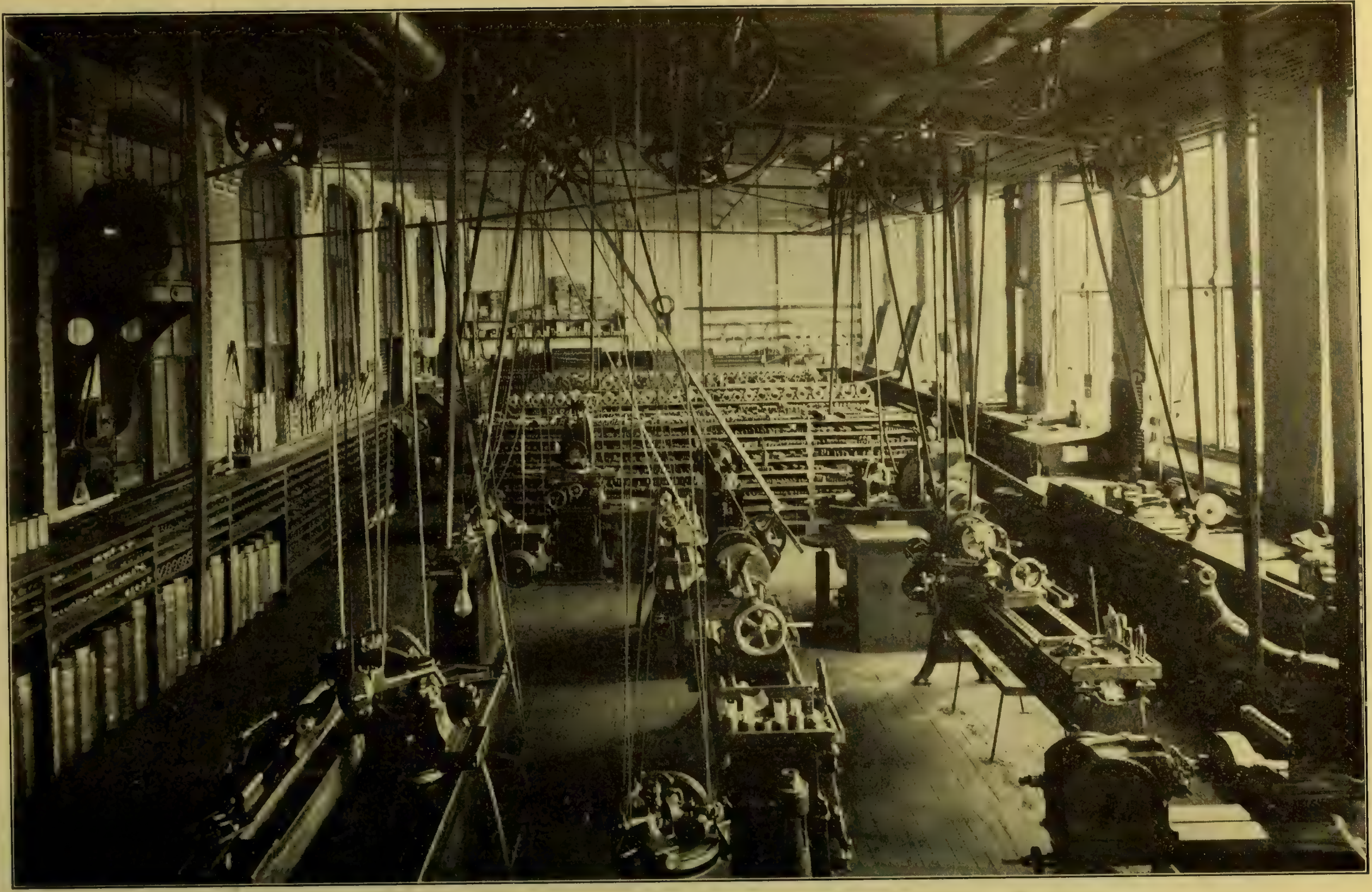
Before dealing more particularly with the functions of the tool room, it may be of interest to some to consider briefly its equipment and location, together with a few other general points, assuming that such a department is about to be established.

The Location of the Tool Room.—If the shop is comparatively small, it is advisable to select a fairly central position, so that the tool store may be easily accessible from all parts, and, when possible, the tool room should be in close contact with the store. A good position for the tool room may sometimes be found upon an upper floor or gallery, with the store immediately below connected by a stairway and a light hoist. Due consideration should be given to the possible future need for expansion, both of the tool room itself and the store. The situation should be as light as possible, and the floor, if above ground, needs to be sufficiently rigid to avoid excessive vibration. The probable temperature should also be noted to ensure a fair mean, without extremes. By all means let the tool room and store be divided from the other portions of the shop, and let it be an offense for the ordinary workman to enter it without permission. It should be looked upon as a prize and a mark of ability for the man in the shop to be accorded a place in the tool room.

In a large works, it will no doubt be necessary to have several tool



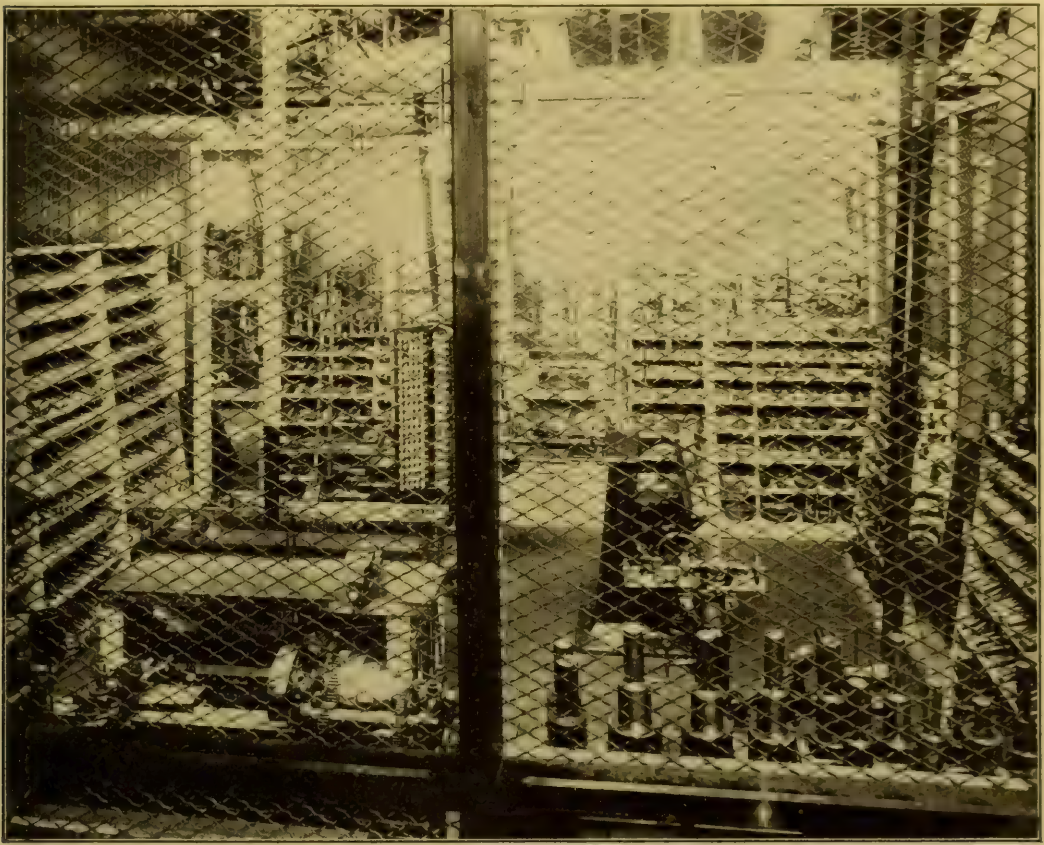
THE UPPER ILLUSTRATION SHOWS THE TOOL ROOM OF MARSHALL, SONS & CO., LTD., BRITANNIA IRON WORKS, GAINSBOROUGH, ENGLAND. THE LOWER ONE SHOWS THE TOOL ROOM OF THE NILES TOOL WORKS, HAMILTON, OHIO.



TOOL ROOM IN THE POND MACHINE TOOL WORKS OF THE NILES-BEMENT-POND COMPANY, PLAINFIELD, N. J.

At the end are seen the storage racks, illustrated in more detail on page 541.

stores conveniently situated for the various parts—such, for instance, as a store for the turret-lathe department, another for the milling department, and still another for the turnery and drilling sections, according to the shop arrangement. In this case the actual position of the tool room will be less important, as the stores are, of necessity, severed from it. The plant that will be required will include:—

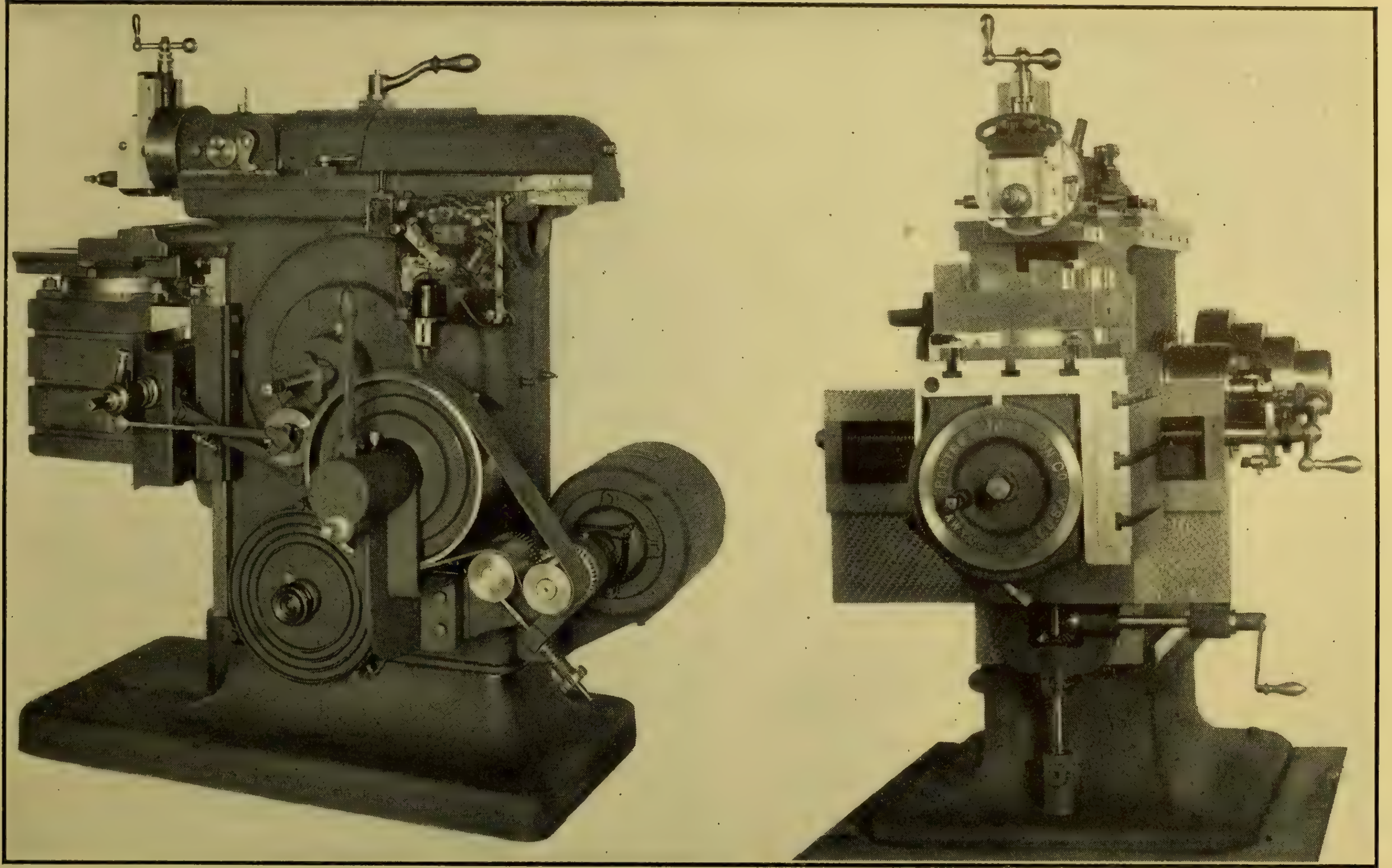


ONE OF THE SMALL DEPARTMENTAL TOOL ROOMS, MACHINE SHOP OF ALFRED HERBERT, LTD., COVENTRY, ENGLAND.

Equipped with lathe, universal grinder, large and small cutter grinders, gear-cutter grinder, large and small twist-drill grinder. All taps, drills, arbors, limit gauges, etc., are kept here and given out on checks; the revolving check board is seen in the middle of the room. The departmental system is devised to keep the tools for each class of work as near as possible to the workmen using them.

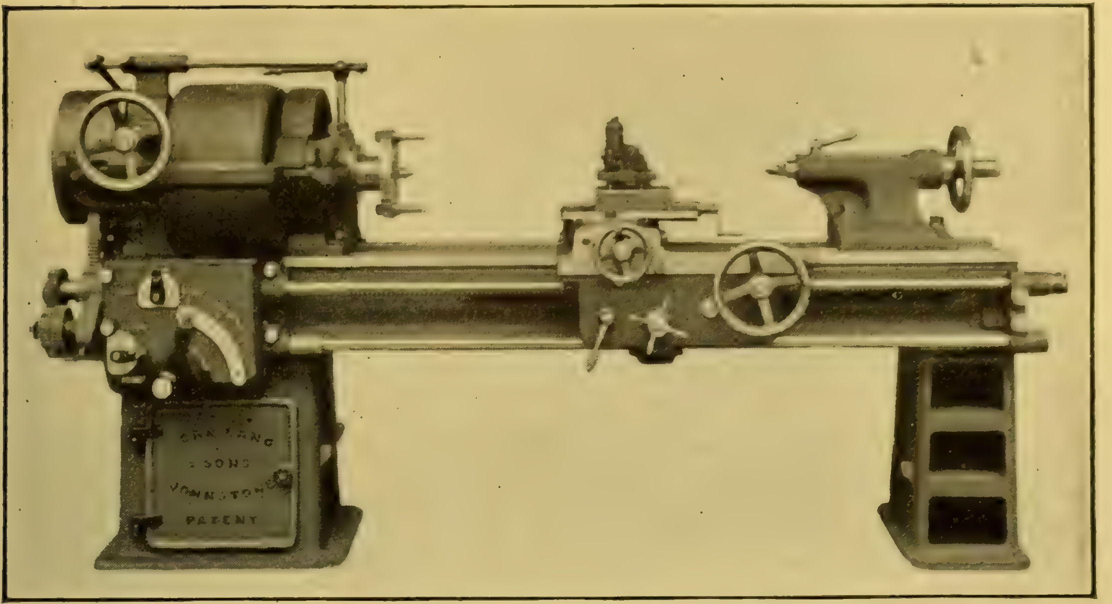
1.—High-class light lathes of from 6 inch to 8 inch centres, fully equipped with jaw chucks, driving and face plates, stationary and traveling steadies, taper- and former-turning attachment upon the rear of the machine, change wheels, traverse shaft, and an accurate leading screw. On page 527 is shown Lang's most recent lathe with self-contained speed-regulating gear and no countershaft needed.

2.—A larger lathe of about 10-inch centres with a gap is also very useful for swinging jigs, especially so if it also has a fairly long bed so that it may be used for boring bars, coneing out drilling-machine spindles, etc., under repair.



SHAPERS ADAPTED TO THE REQUIREMENTS OF TOOL-ROOM USE.

That on the left is a 16-inch motor-driven crank shaper by the Stockbridge Machine Co., Worcester, Mass. The novel belt drive, which secures almost the positiveness of a chain drive, is noteworthy. On the right is shown a 15-inch universal shaper by the Potter & Johnson Co., Pawtucket, R. I. It has power-driven feed on any angle with ten changes of speed, automatic feed stop, swivel table with auxiliary tilting side for compound angles; feed screws have graduated collars for fine adjustments.



A LATHE SUITABLE FOR TOOL-ROOM USE.

With variable speed drive. Made by John Lang & Sons, Johnstone, Scotland.

3.—Where much heavy milling is done, necessitating form cutters, a relieving lathe of the Reinecker type is a good machine to have in the tool room, although if small formed cutters only are used they may be done by such an adaption as is fitted to the Hendey-Norton lathe for this purpose. See page 530.

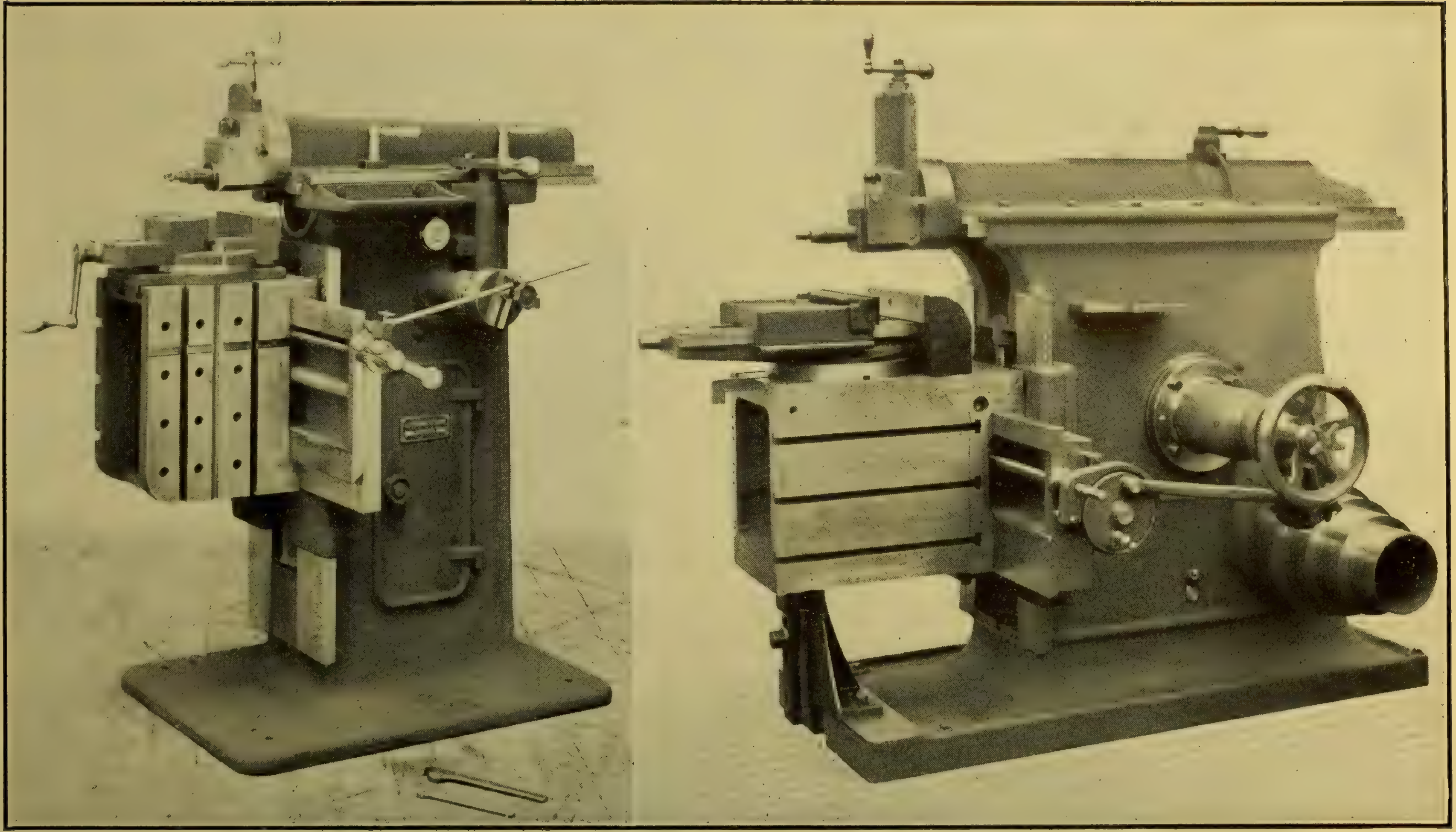
4.—One or more rack-geared shaping machines of from 24-inch to 30-inch stroke, giving a constant cutting speed with quick return, will also be necessary. Such a machine by Ludwig Loewe & Co. is illustrated on page 528.

5.—If much large jig work has to be done, a planer of suitable size might be wanted; but it would be unwise to put one down unless there were a probability of sufficient work to keep it occupied.

6.—In a small tool room, one vertical drilling machine will be wanted, of the "Standard" type with graduated sleeve, back gear, rise and fall spindle bracket, and a two-speed countershaft giving a range of speeds suiting it for drilling and also for boring with bar and cutters. Unless there is such a countershaft giving the two speeds, much boring work necessary on jigs becomes very awkward.

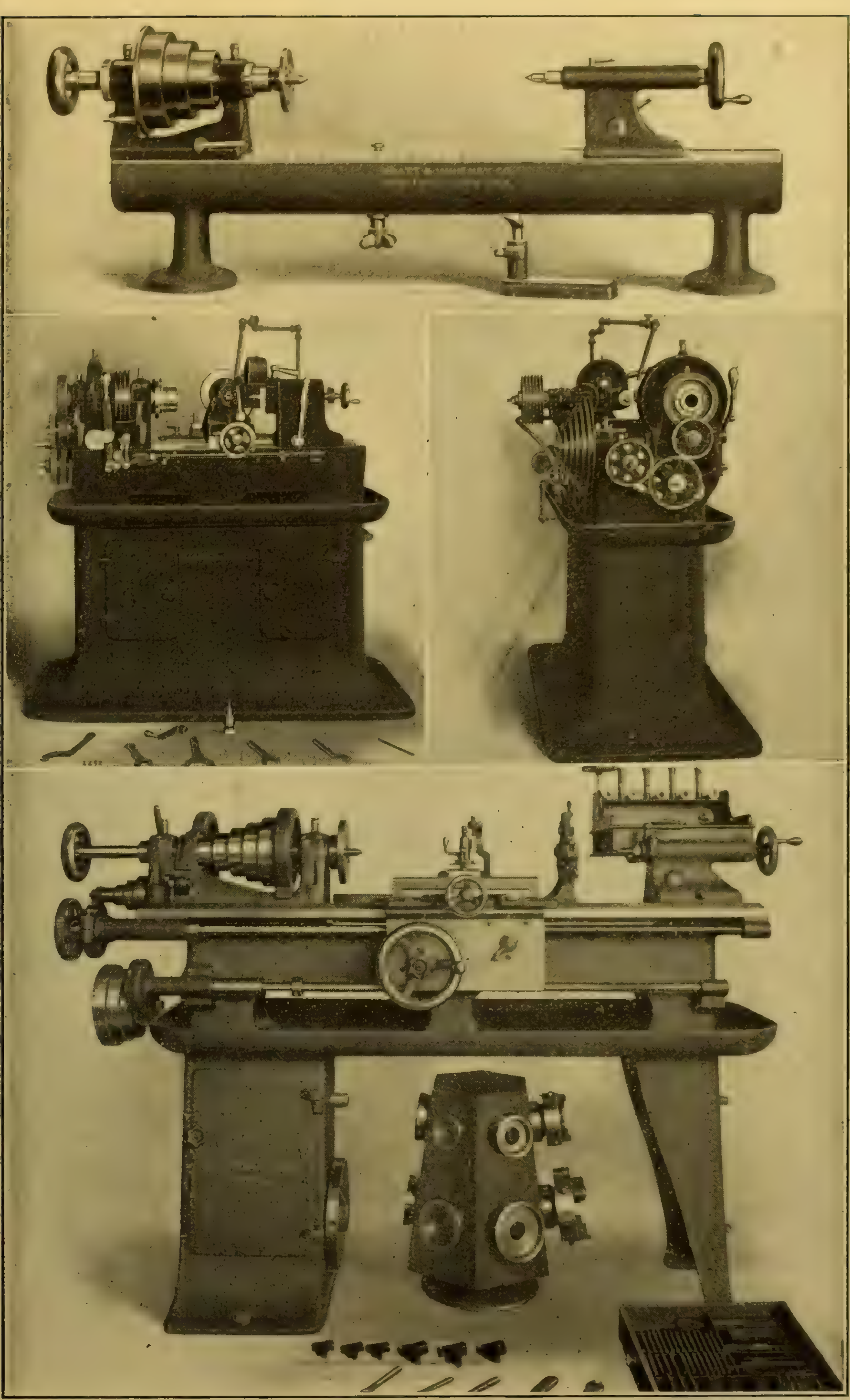
7.—A small universal radial drill will be very useful in a larger tool room, but with such a machine it would be well to have a flying stay for the arm to prevent lift when accurate jig boring is being done.

8.—An absolutely indispensable tool for tool room use is a universal back-geared milling machine fully provided with all auxiliaries, such as:—A pair of dividing heads fitted with both centres and self-centering chuck; a machine vise that may be angled in either direction;

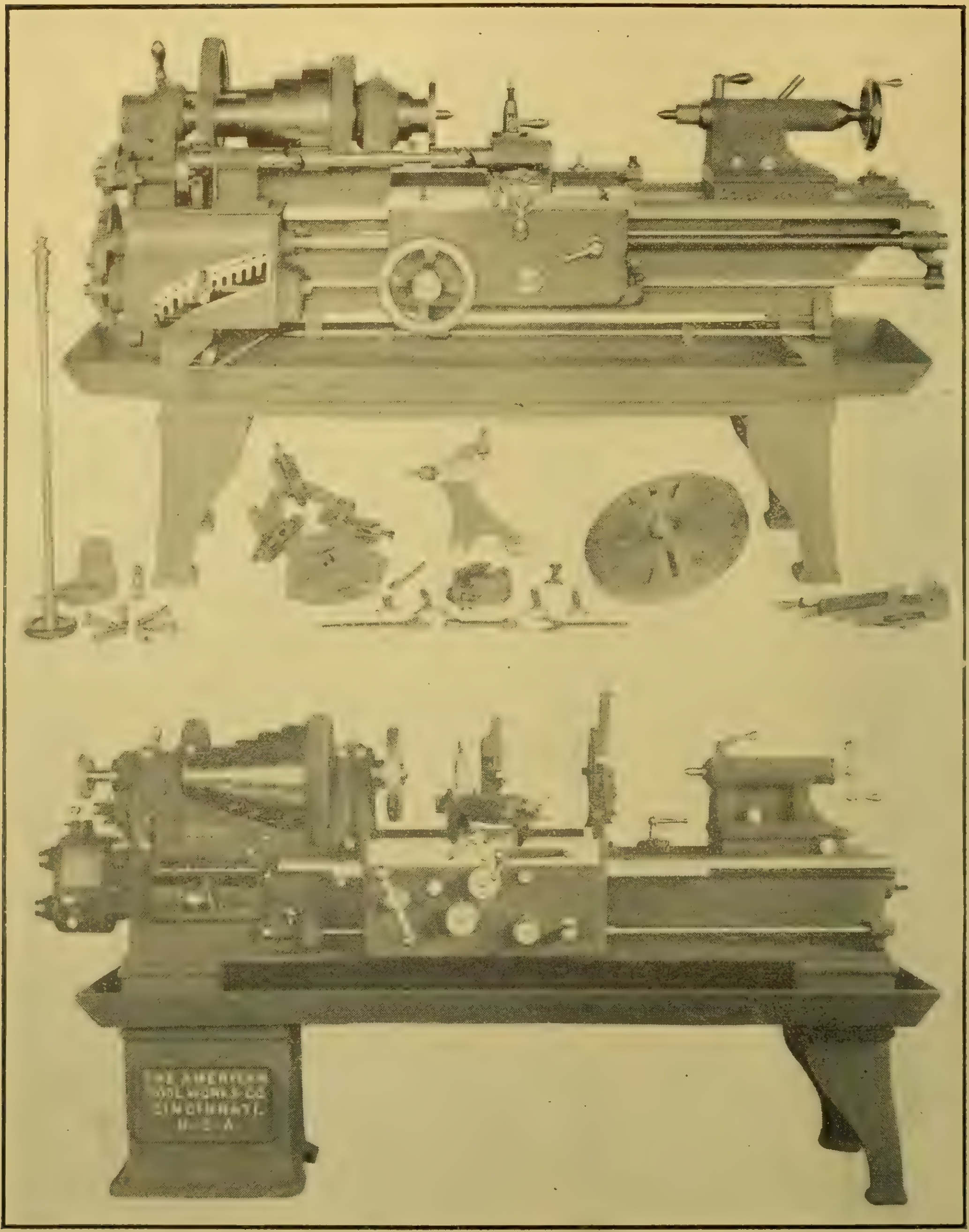


SHAPERS ADAPTED TO THE REQUIREMENTS OF TOOL-ROOM USE.

On the left is a rack-geared shaper by Ludwig Loewe & Co., of Berlin; on the right a shaper by the American Tool Works Co., of Cincinnati, Ohio.



SOME TOOL-ROOM EQUIPMENT FROM THE PRATT & WHITNEY CO., HARTFORD, CONN. At the top is a 7 by 32-inch bench lathe; next, the front and end views of a 6 by 14-inch thread milling machine; at the bottom, a 10-inch by 5-foot toolmaker's lathe.

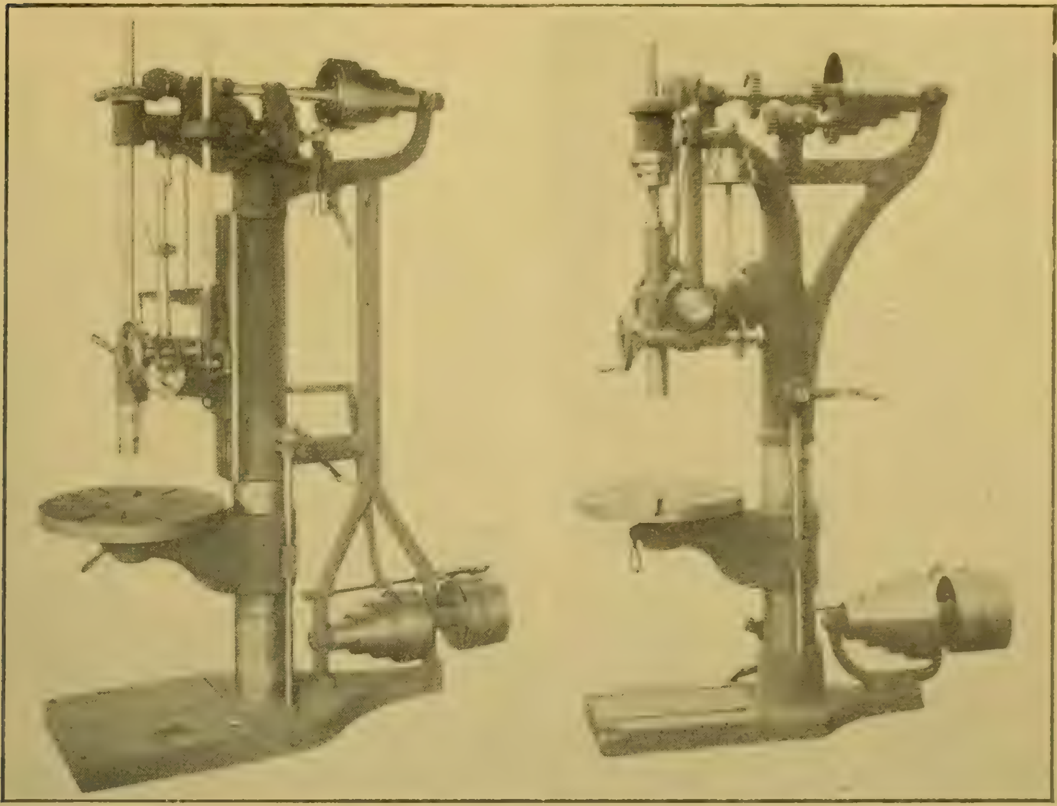


EXAMPLES OF TOOL-ROOM LATHES.

The one above is a Hendey-Norton 16-inch swing, made any length of bed, with relieving attachment for automatically backing off clearance on the teeth of hobs, mills, and forming cutters. It has a range of 2 to 26 divisions and may be set at any angle up to 30 degrees for backing off the sides of teeth. The lower figure shows a 16-inch engine lathe with pan, draw-in collet, and chuck, by the American Tool Works Co., Cincinnati, Ohio.

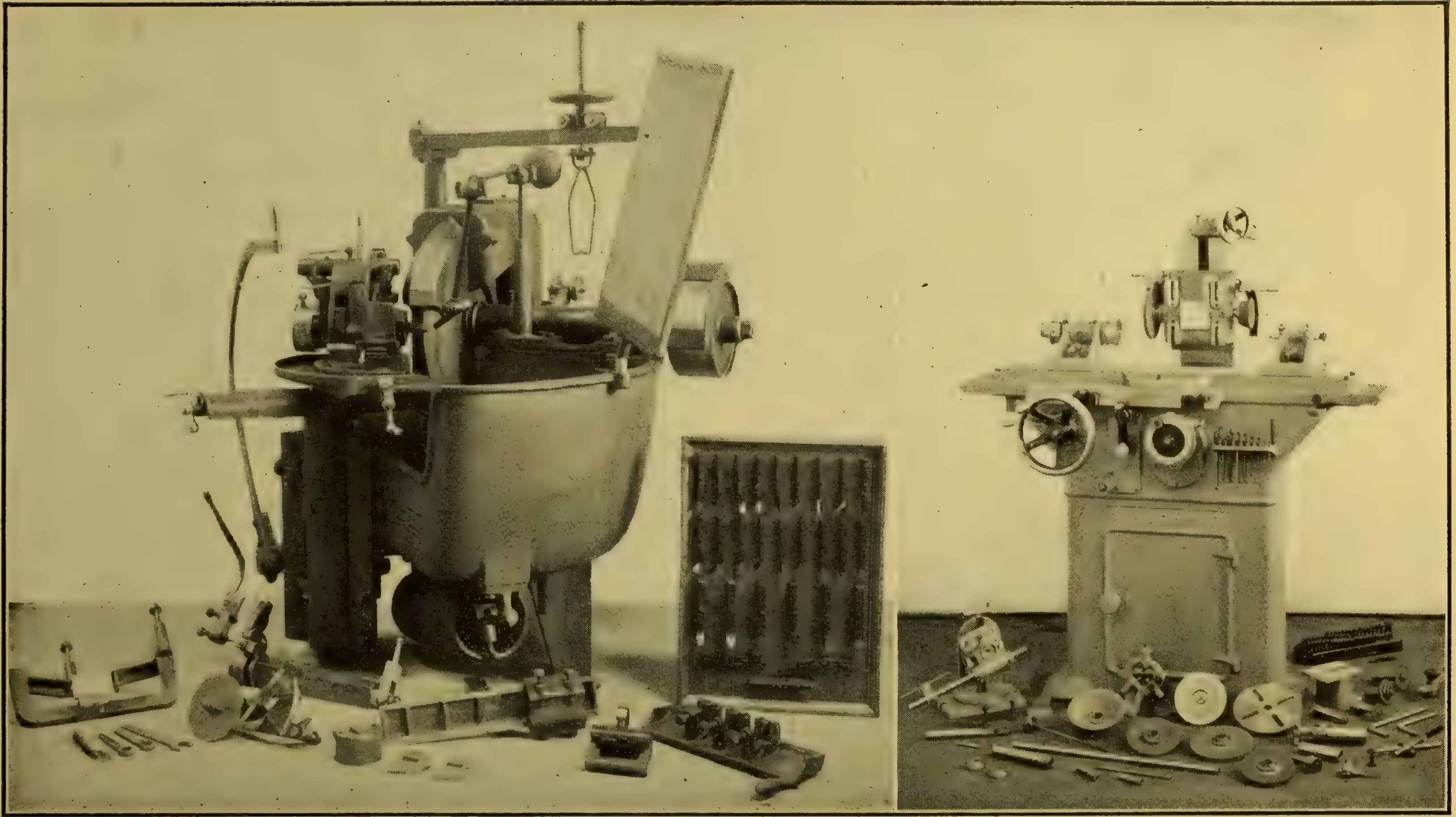
and supports for work, together with a full range of cutters and arbors. In a large tool room, of course, further milling machines will be wanted, but they need not be universal. Perhaps a plain horizontal machine, and also (in cases where pattern or die work has to be done) a vertical spindle mill, will be of very great service.

We now come to the final, and what perhaps might be considered the most important, tool equipment for this department, namely, the grinding machines and appliances.



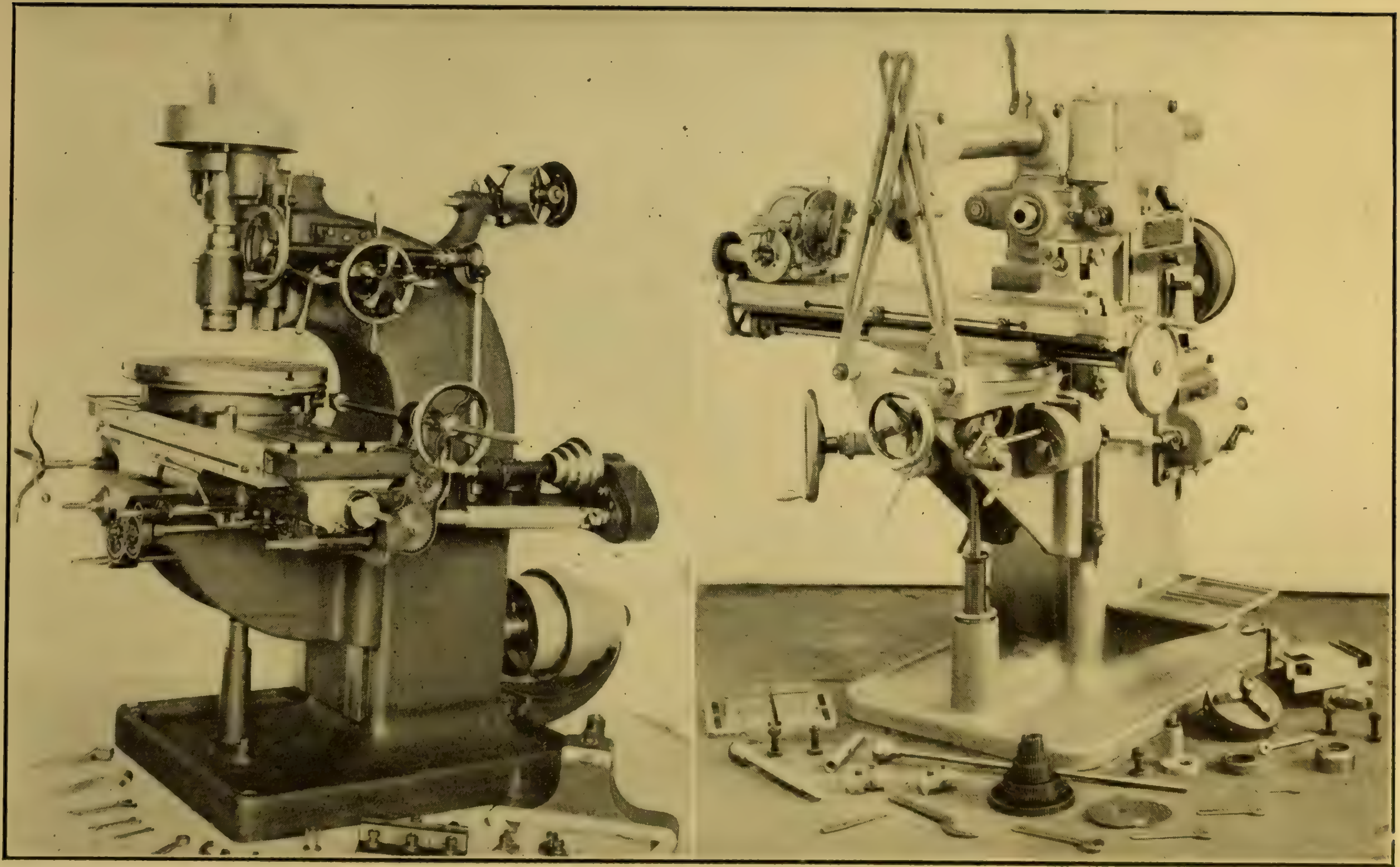
TYPES OF DRILLS FOR TOOL-ROOM USE.
On the left is a 26-inch drill with back gear, positive self feed, and automatic stop, by W. F. & John Barnes Co., Rockford, Ill. On the right is a drill made by the American Tool Works Co., Cincinnati, Ohio.

For the preparation of simple tools for turning, shaping, etc., a grinding machine such as the Sellers or the Gisholt will be almost indispensable. For the grinding of milling cutters a good form of cutter grinder will be required, and this should preferably be of the so-called universal type, that it may be used for any kind of cutter or reamer and also for the small work such as bushes and arbors. For general grinding work a good universal grinder will be needed, and this should, by preference, be large enough to take both lathe and drilling-machine spindles up to moderate sizes, in order to grind their journals when under repair. It should of course be fitted with the various appliances for all classes of work, including internal grinding, face grinding upon thin discs (for which a magnetic chuck is desirable) and also it should have draw-back arrangements for working either a collect chuck or a face-plate attachment. Of this kind of machine I prefer a design in which the emery wheel has as little movement as possible, beyond its own rotation, excepting for the pur-



EXAMPLES OF TOOL AND UNIVERSAL GRINDING MACHINES.

On the left is a tool-grinding machine made by Wm. Sellers & Co., Philadelphia. It is shown as equipped with a model board and instruction sheet. On the right is a Brown & Sharpe grinding machine, designed to meet the requirements of the tool room in the grinding of milling and formed cutters, beveled cutters, straddle and face mills, reamers, etc., and also for cylindrical grinding.

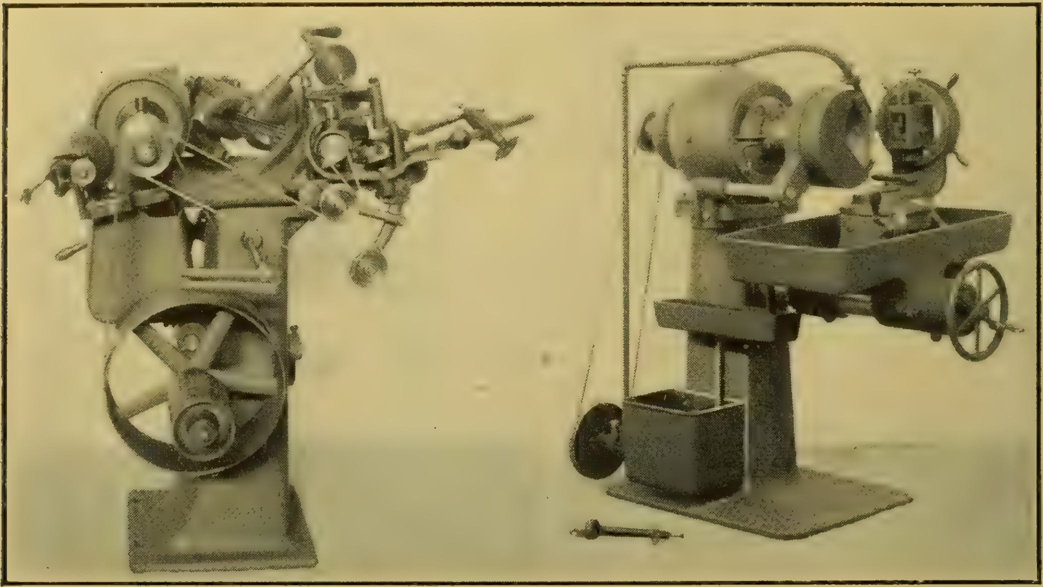


MILLING MACHINES FOR THE TOOL EQUIPMENT OF THE TOOL ROOM.

On the left is a vertical milling machine by the Becker-Brainard Milling Machine Co., Hyde Park, Mass. It has power feed to rotary and longitudinal feed to table. The cutter works in plain sight and the easy handling of the work table adapts the machine to irregular work. On the right is a 23 by 7½ by 17½ universal milling machine by the Brown & Sharpe Co., Providence, R. I. It is adapted to constant-speed motor drive, with hand or power vertical feed.

pose of feeding; for it is my experience that the firmer the headstock and the more rigid its connections, the higher is the quality of the work produced. The Brown & Sharpe machine, page 532, is a good machine for the work.

Another necessary machine is a twist-drill grinder, and this should advisably have a flow of water upon the stone and also a point-thinning attachment. Many of the machines for this purpose which are upon the market are very unsatisfactory in use, the general fault being the extreme difficulty in obtaining cutting lips of exactly equal length. Most of the machines aim at giving a correct angle and sufficient "backing off," but the most important requisition—namely, equal length of cutting lip—depends entirely upon the care and skill of the operator.

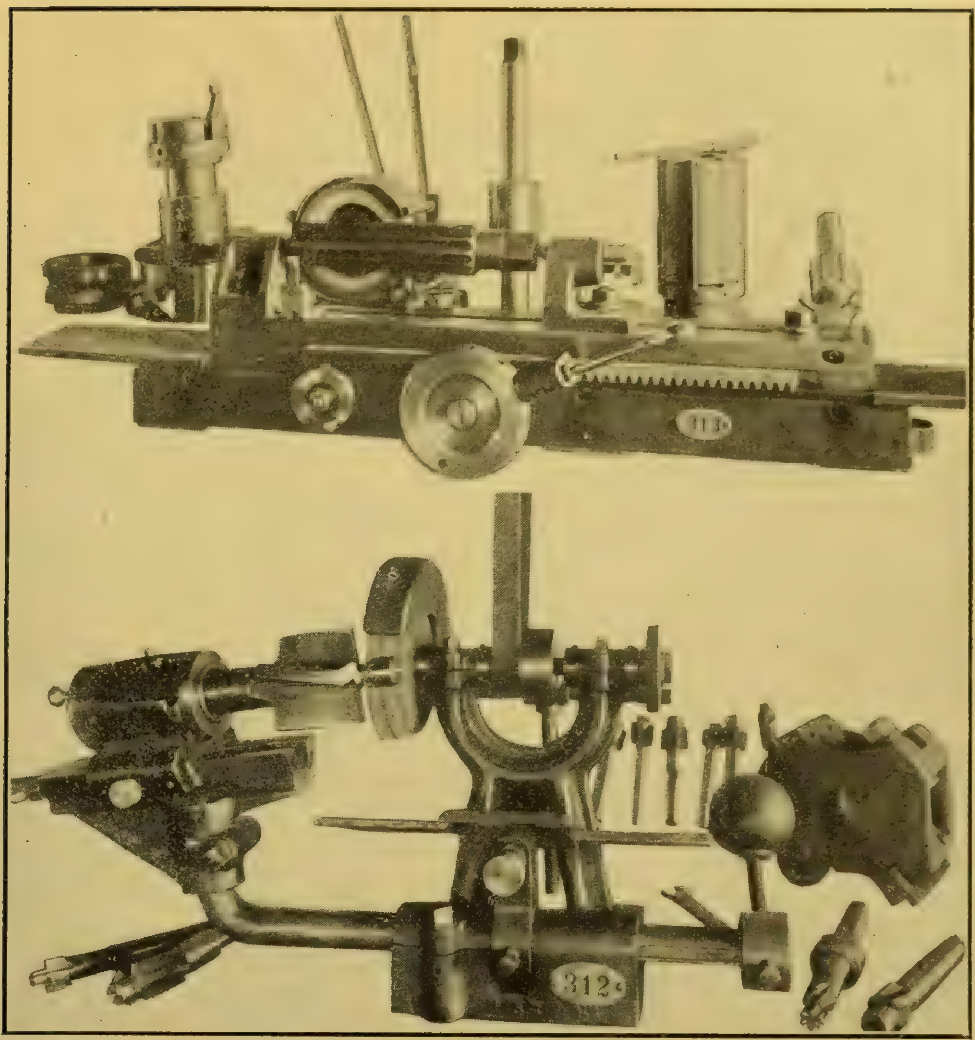


GRINDING MACHINES FOR TOOL-ROOM USE.

On the left is a drill-grinding and pointing machine made by Wm. Sellers & Co., Philadelphia. On the right, a tool grinder by the Gisholt Machine Co., Madison, Wis. A tool held in the tool holder may be moved about four different centers.

The machine-tool equipment of the tool room, if of small size, would now be completed with the addition of a small sensitive drill, a centring machine, a hack saw, a touching-up stone, and an arbor press. With such equipment as that described, together with accommodation for ten or twelve fitters, the tool room would be sufficient for a factory employing about five hundred hands, engaged upon general machine work, steam or gas engines. In establishments manufacturing machinery requiring large quantities of small detail work, the tool department would be larger in proportion, as would also be the case where much stamping or press work has to be done.

An initial small-tool kit purely for tool-room use is the next point



TOOL-GRINDING APPLIANCES DESIGNED BY THE BULLARD MACHINE TOOL COMPANY FOR THEIR OWN SHOP.

Above is a special grinder for straight and taper reamers. It uses an India corundum wheel, and it is not necessary to stone the reamers by hand afterward. The lower figure shows a special counterbore-grinding machine, which being used only for counter-bores does not require resetting for each job.

for consideration, and for this we must of necessity start with standards of measurement. A series of plug and ring gauges from 1/4 to 4 inches, ranging by 1/16 inch to 2 inches and by 1/8 inch beyond that, are of course necessary, although possibly some would find it sufficient to range by 1/16 inch to 1 inch, by 1/8 inch to 2 inches, and by 1/4 inch above that.

In addition to these, a set of standard end measuring blocks from 1/16 inch to 4 inches will be found extremely useful. For measurements above 4 inches, measuring rods rising by 1/2 inch up to such length as the needs of the establishment may indicate, will probably be required. These may be used in conjunction with either a measuring machine or a vernier to get any dimension wanted. A set of standard snap gauges from 1/4 inch up to 8 inches or 10 inches would be found to be in frequent demand for tool-room use, and if these are supplemented with some taper gauges, such as Morse or Brown and Sharpe, the initial equipment of plain standards will be complete.

With regard to screw gauges:—perhaps the most satisfactory provision to make in this direction by way of standards, is to have a set of standard screw plugs for reference only, and to provide adjustable screw gauges instead of solid screwed rings, so that they may be set to the plugs from time to time in order to compensate for wear. Solid screwed ring gauges are apt to be unsatisfactory in use, as they must be soft, and it is so very easy to force them that in quite a short time, perhaps a few weeks, they would be unfit for use as standards. Plugs cannot be forced in this way so easily; thus they will retain their size more accurately and form a reasonable standard from which to work.

The small-tool kit will be completed when screwing tackle, solid and adjustable reamers, mandrels, outside and inside micrometers, etc., have been added to the list. Limit gauges are quite the right things to provide for general manufacturing purposes, but unless the limits are made extremely small, they can scarcely be considered suitable for the production of fine tools.

The Functions of the Tool Room.—Speaking in a broad sense, the prime function of the tool room is to act in the capacity of an arsenal to provide the management with the necessary weapons to wage war upon excessive cost. The word excessive is here used to indicate any excess of cost beyond that minimum at which it is possible to produce the articles to be manufactured.

The cost is bound to be in excess:—

1.—If the producing machines of the factory are not properly tooled.

2.—If the small tools are not kept in a proper state of repair.

3.—If the gauges and measuring appliances for shop use are not kept within the necessary degree of accuracy.

4.—If the tools provided are not ready for use.

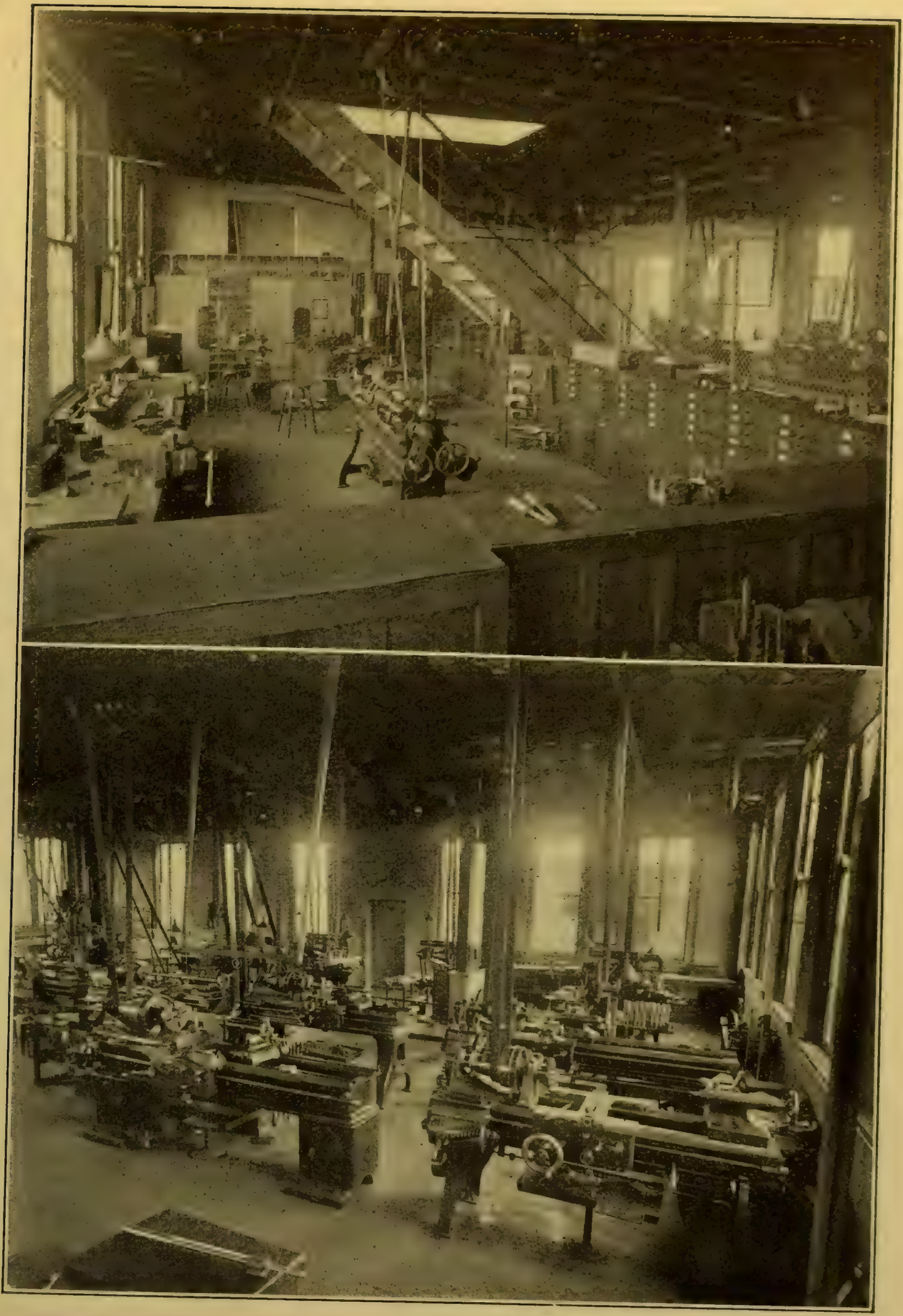
5.—If they cannot be found when required.

6.—If they are not actually used upon the jobs for which they have been prepared.

7.—If the producing machinery is not kept in an efficient state of repair.

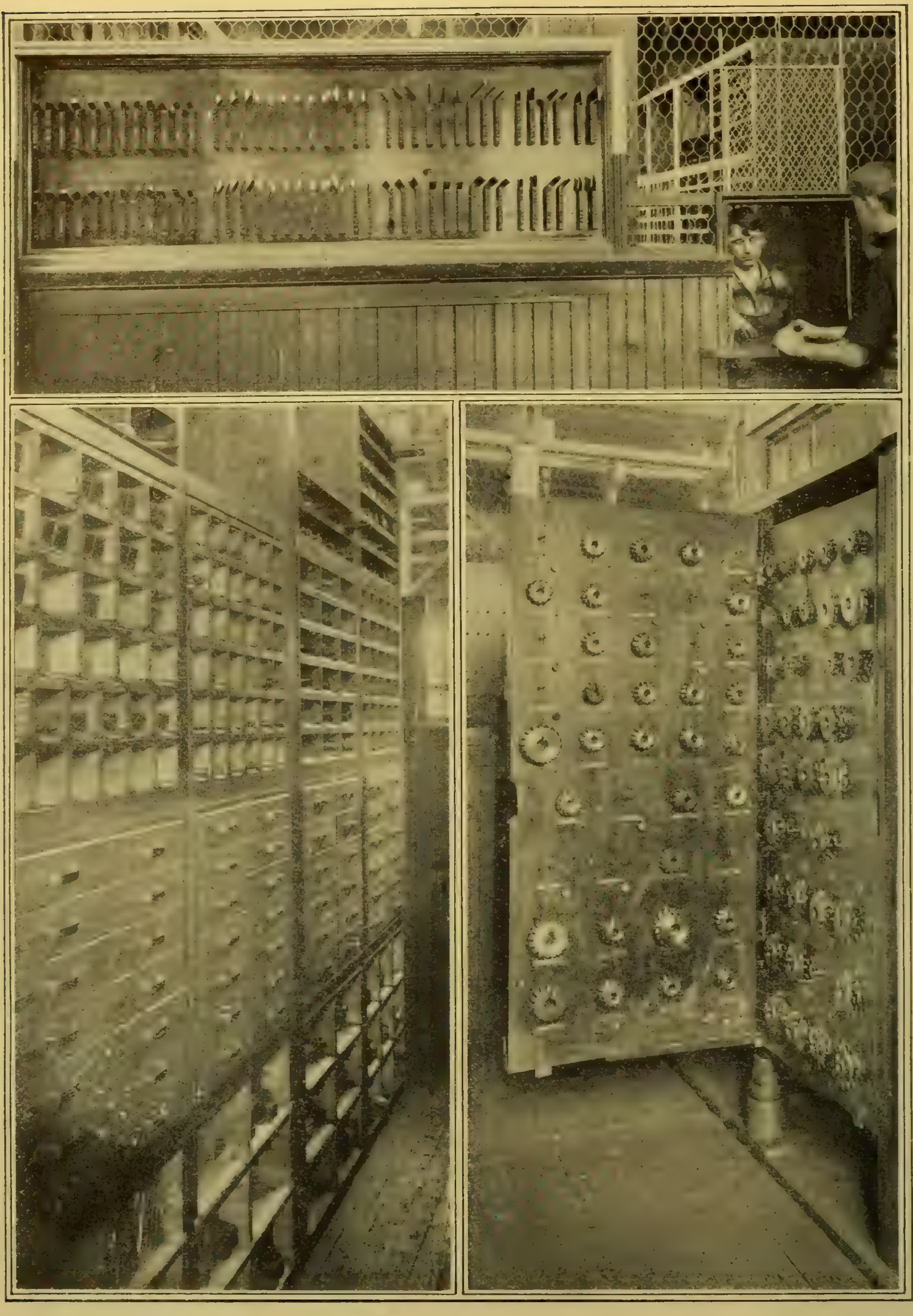
Hence the functions of the tool room may be said to embrace these several requirements.

The efficient fulfilment of the several functions mentioned will depend:—



TOOL ROOM OF THE CINCINNATI MILLING MACHINE CO., CINCINNATI, OHIO.

In the tool-making department, shown in the lower picture, all special tools are made on requisition from department head signed by general foreman or superintendent. In the tool storage (20 by 60) seen above, small tools are arranged in the drawer cabinets and closets seen at the right and across the foreground. A card index gives the closet, drawer, or shelf number of each tool or jig. Each foreman has a man (tool carrier) whose business it is to have all tools and jigs ready for each operator starting a job. He gets the list from a blue print handed him by the foreman when he specifies the next job for any workman.



FEATURES OF THE TOOL-ROOM SYSTEM OF THE LINK-BELT ENGINEERING COMPANY, PHILA.

At the top is shown the model board, carrying cast-iron models of all standard lathe tools. The workman consults this and orders the required tool by four-letter symbols. Below on the left is the storage for twist drills, sectional dies, large milling cutters, lathe tools, etc. Main racks are in large multiples of the same size, and interior racks in multiples suited to the large racks. Twist drills up to 1½ inch are kept in the drawers. The workman's check is placed on a peg in front of the pigeon hole, or in a pocket in the drawer. Tools are classified under mnemonic symbols. On the right is shown one of the sets of multiple doors, six to a set, upon which are hung milling cutters, gear cutters, solid dies, etc. This system, illustrated further on page 547, was installed by Messrs. Dodge & Day.

First; upon the method of storing and keeping track of tools.

Second; upon the system of marking the tools and appliances.

Third; upon the means provided for indicating to the workmen in the shops the tools that are to be used upon the jobs they may have in hand.

The first item, that of storing tools, is covered by the method of working the tool stores.

The conditions to be met by the system of storage are briefly as follows:—

(a) It should be simple and not too expensive.

(b) It should be readily expansible.

(c) It should provide a place for every tool it has to accommodate, which place should be strictly reserved for its particular tool and be identified with it.

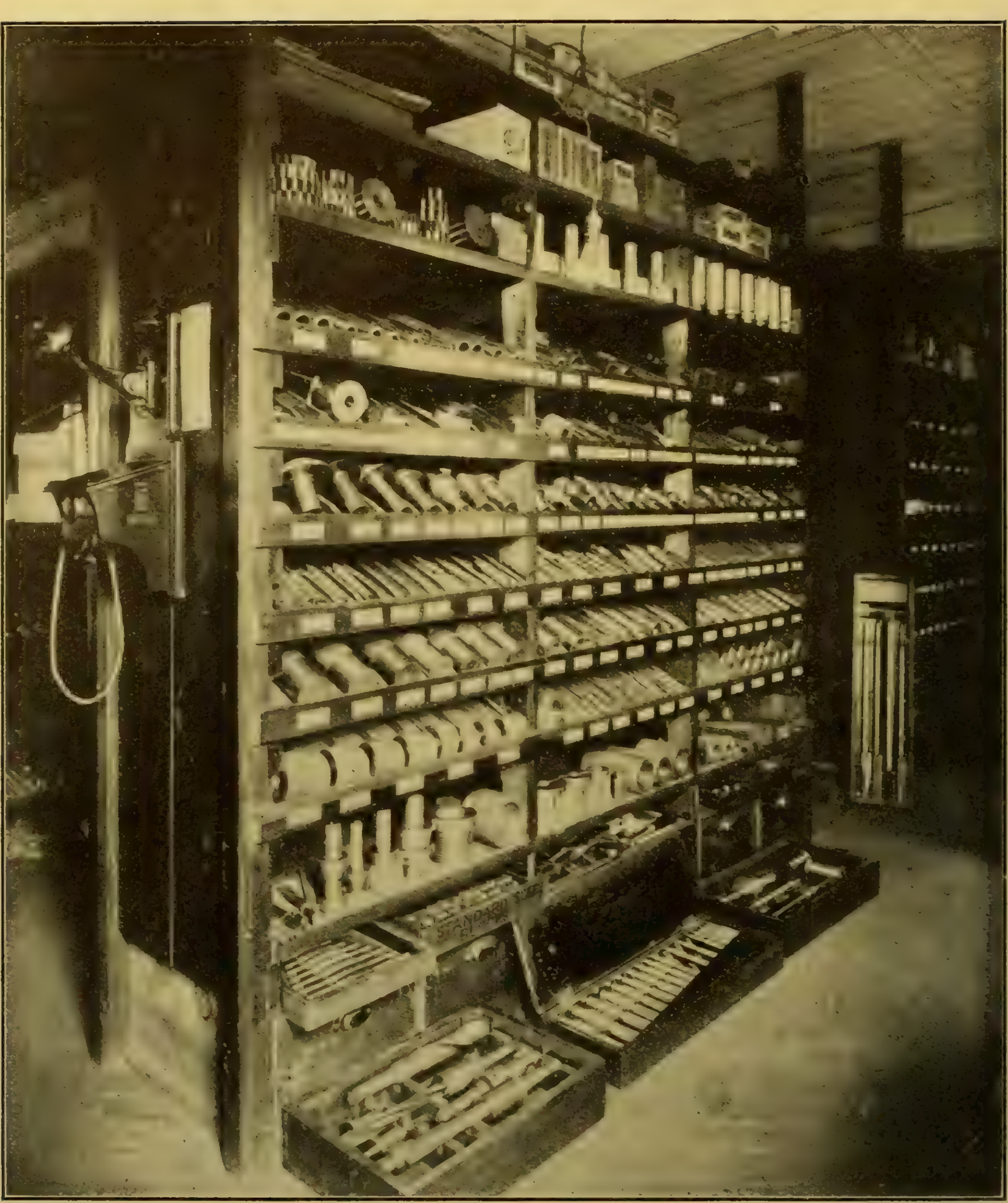
(d) It should provide a ready means for indicating where any tool is when not in store.

(e) It should show what tools any man has in his possession at any time.

Probably as cheap a method of storage as any that could be devised is by an arrangement of pigeon holes, but it fails on several of the more important points. I have found by experience that any one system of storage will not cover, or rather accommodate, all types of tools and gauges for which provision must be made, and I therefore put forward three methods that have been found most useful.

The Tray System.—An arrangement of pigeon holes that may be adjusted vertically may provide a means of storage that is economical in the matter of space, and to this the tray system may be likened, with the additional advantage that the portion of the pigeon hole upon which the tools rest may be drawn forward as though it were a drawer.

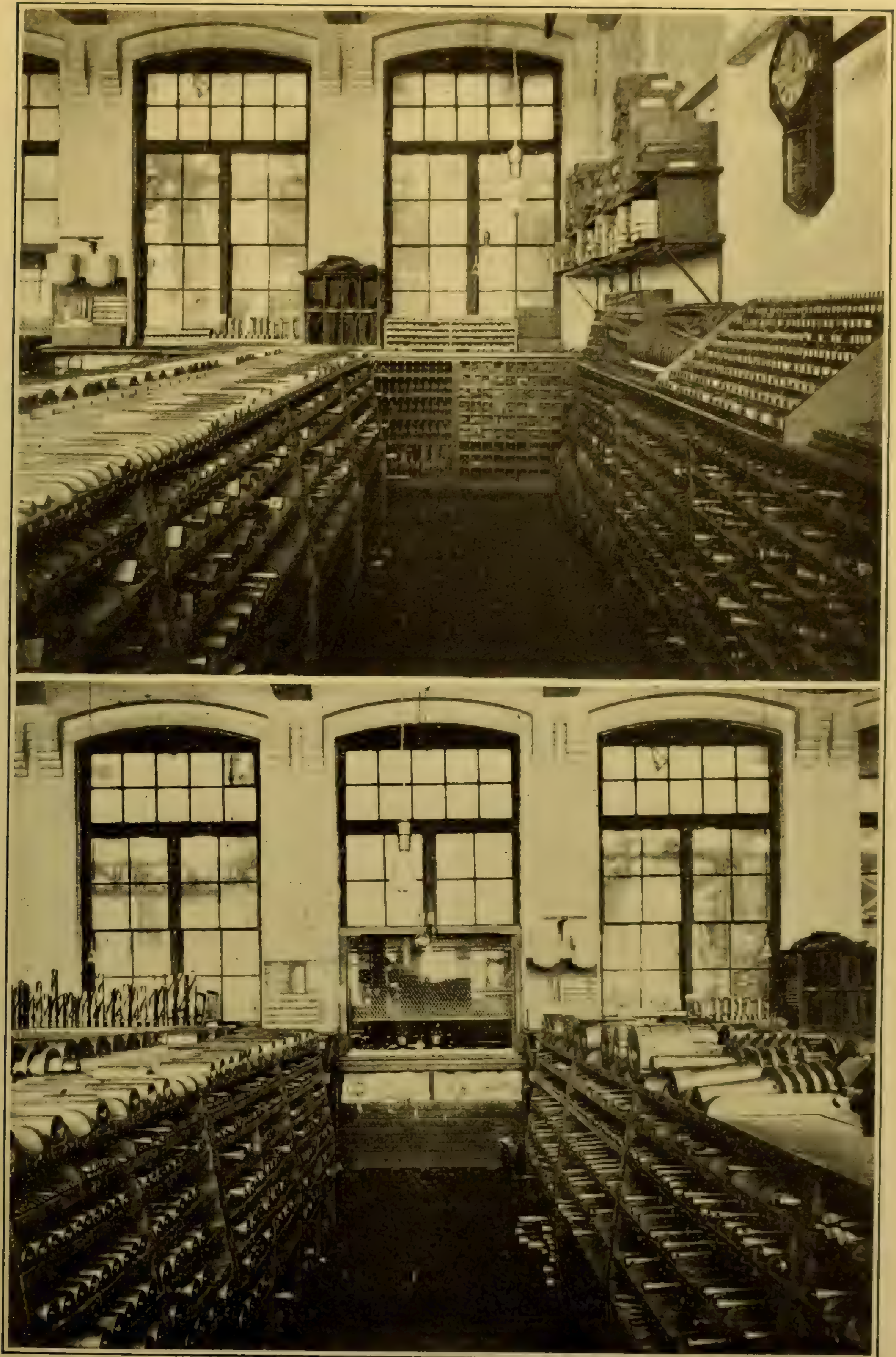
The storage space is provided by forming a series of vertical partitions from timbering about 1 inch thick and 15 or 16 inches apart, with a depth from 28 to 30 inches. These partitions should be carefully set at the right distance from each other so that the trays may interchange between the several bays so formed. The trays themselves are built up with two side strips of hard wood about 1½ to 2 inches broad and ¾ or ⅞ inch thick. These hard-wood pieces are grooved, and form clamps for the central portion of the tray, which is made of softer material with the grain running in the direction of the width of the tray. The central portion does not need to extend more than 24 inches from front to back, which allows the hard-wood sides to project beyond the central portion to the rear. Runners of



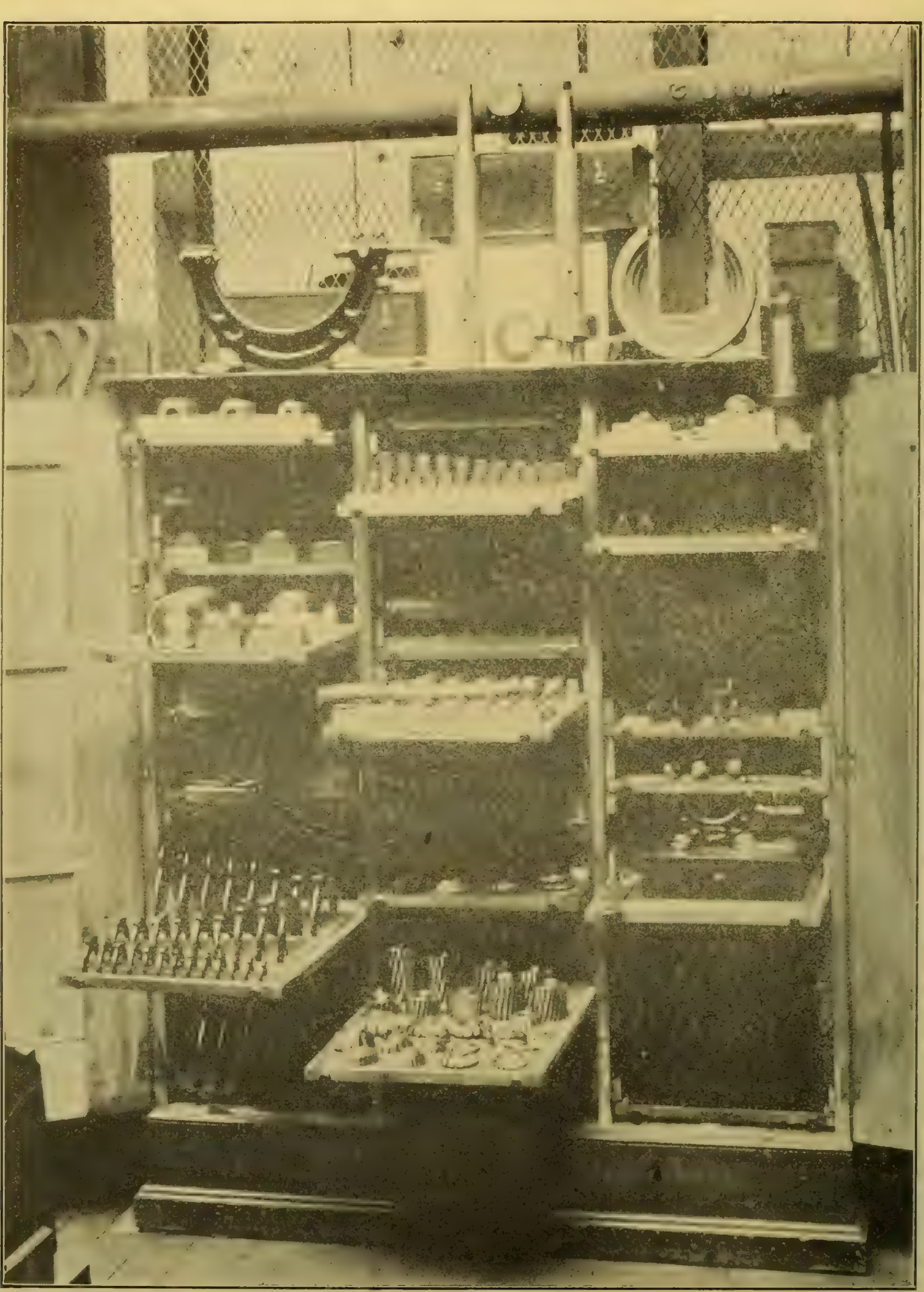
TOOL-STORAGE ROOM, SHOWING METHOD OF CARING FOR ARBORS, GAUGES, ETC., IN THE SHOPS OF THE BULLARD MACHINE-TOOL CO., BRIDGEPORT, CONN., U. S. A.

hard wood about ½ inch thick and 1½ inches broad are screwed to the partitions, two each above and below the tray, to form grooves in which it may slide.

When initially preparing the arrangement a quantity of trays should be made together with a corresponding number of strips, so that they may be fitted in place as required. The surface of the tray is provided with strips of wood nailed on, or blocks shaped to receive the various tools, grouping them to make the most of the space. The distance from tray to tray is made as small as is possible while accommodating the tools placed upon them. The illustration shown just



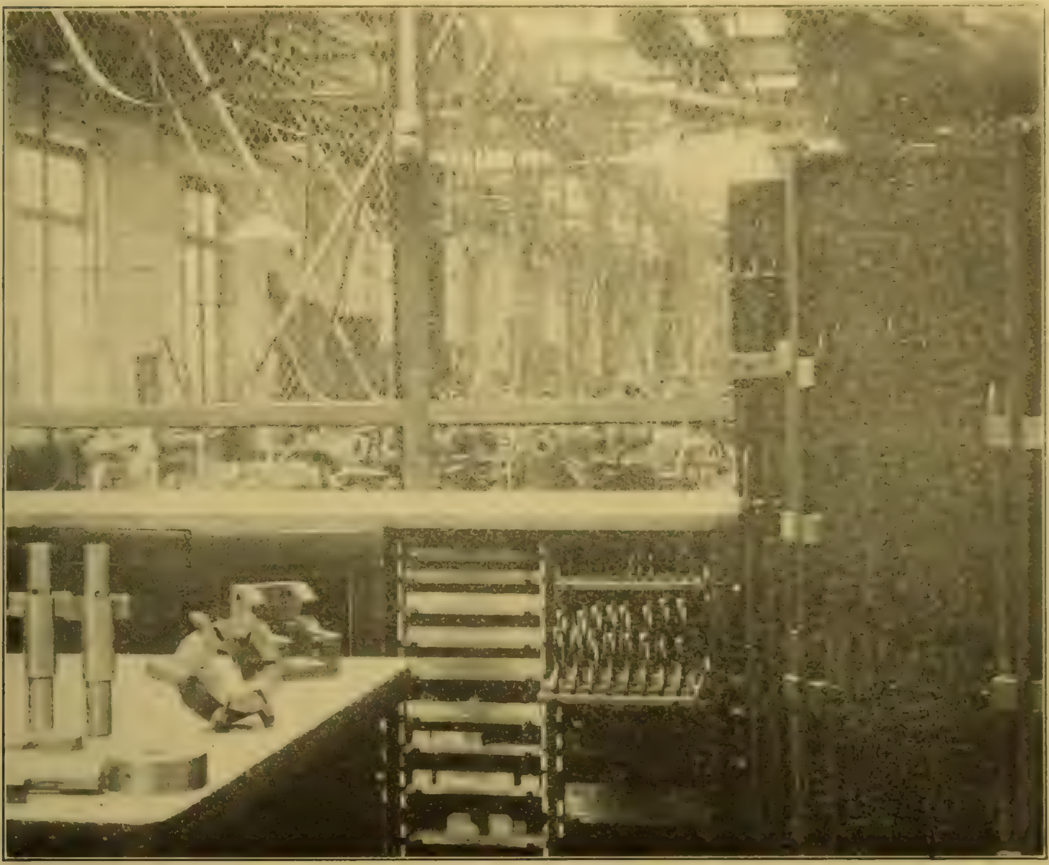
TOOL-STORAGE, POND MACHINE TOOL WORKS OF THE NILES-BEMENT-POND CO.



CABINET FOR TOOLS ARRANGED ON THE TRAY SYSTEM OF STORAGE, IN THE TOOL STORES OF MESSRS. BROWETT, LINDLEY & CO., PATRICROFT, MANCHESTER, ENGLAND.

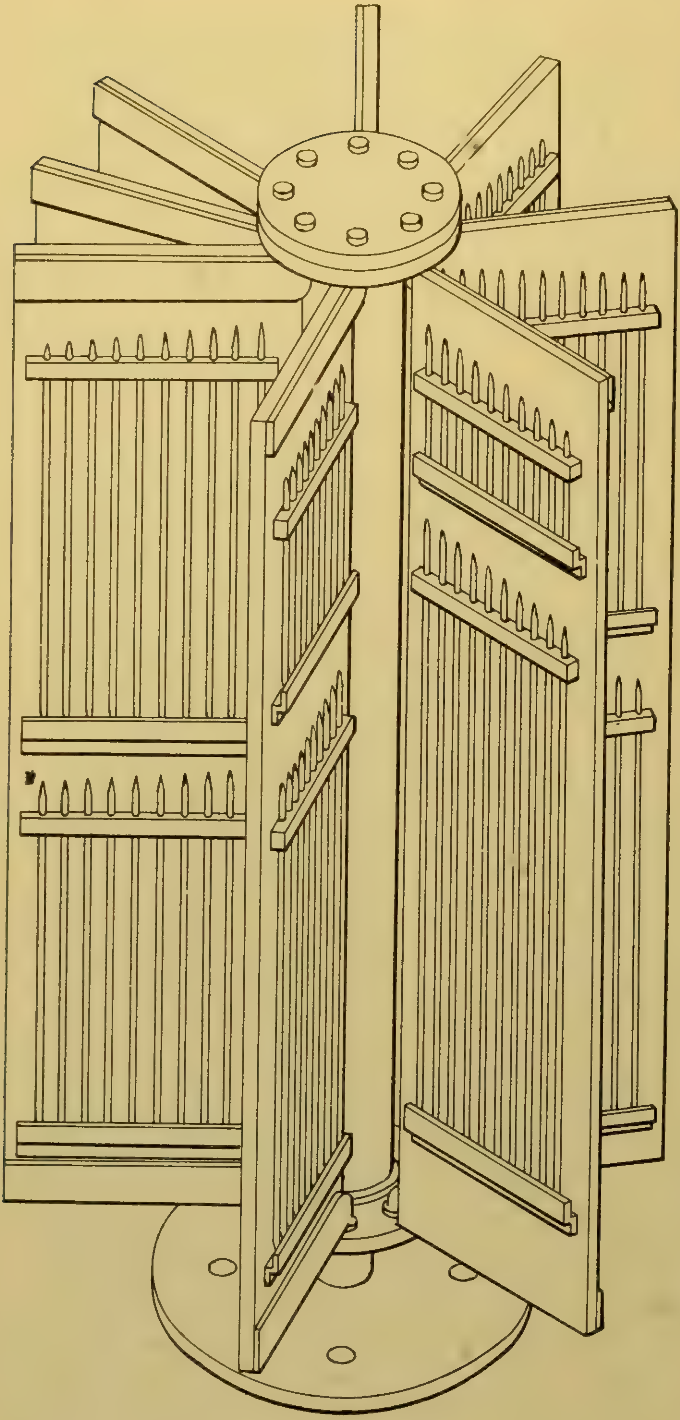
above will assist to make clear the explanation of this most excellent method of storing small tools; more of these trays may be seen beneath the bench on page 543. Upon consideration it will be found to satisfy the conditions enumerated, for it is simple, cheap, expansible, and tidy in appearance.

The Leaf System.—Some articles that require to be stored, while of reasonably small diameter, are too long to be accommodated by trays. Take, for instance, bar or point gauges, long cutter bars, and other tools of like nature. For the storage of such as these, what I have styled the "Leaf System" is as simple in its way as the tray arrangement. It consists of a series of clamped boards about 20 inches wide, ¾ inch thick, and 4 to 6 feet high. These boards are hinged in convenient positions in a similar manner to a door, and upon their sides places are provided to receive the long tools mentioned. This arrangement can be seen to the right of the picture below and in more detail in the drawing reproduced on page 544.



CORNER OF TOOL STORES AT THE WORKS OF MESSRS. BROWETT, LINDLEY & CO., SHOWING THE TRAY AND LEAF METHODS OF STORAGE.

A simple method of arranging a series of leaves of this kind is to take a piece of stout gas pipe about 2 to 2½ inches in diameter, and longer by an inch or so than the leaves to be accommodated. Flanges are fitted to the upper and lower extremities, and they in turn have a number of holes drilled in them to receive strong pivots forming hinges that are attached to the leaves. The upper end of the pipe is fitted with a screwed plug and the whole is dropped over a second pipe or pillar which is pointed at its upper end to form a pivot, while its lower end is firmly secured to the floor by a large flange. This de-



REVOLVING TOOL RACK FOR "LEAF SYSTEM."

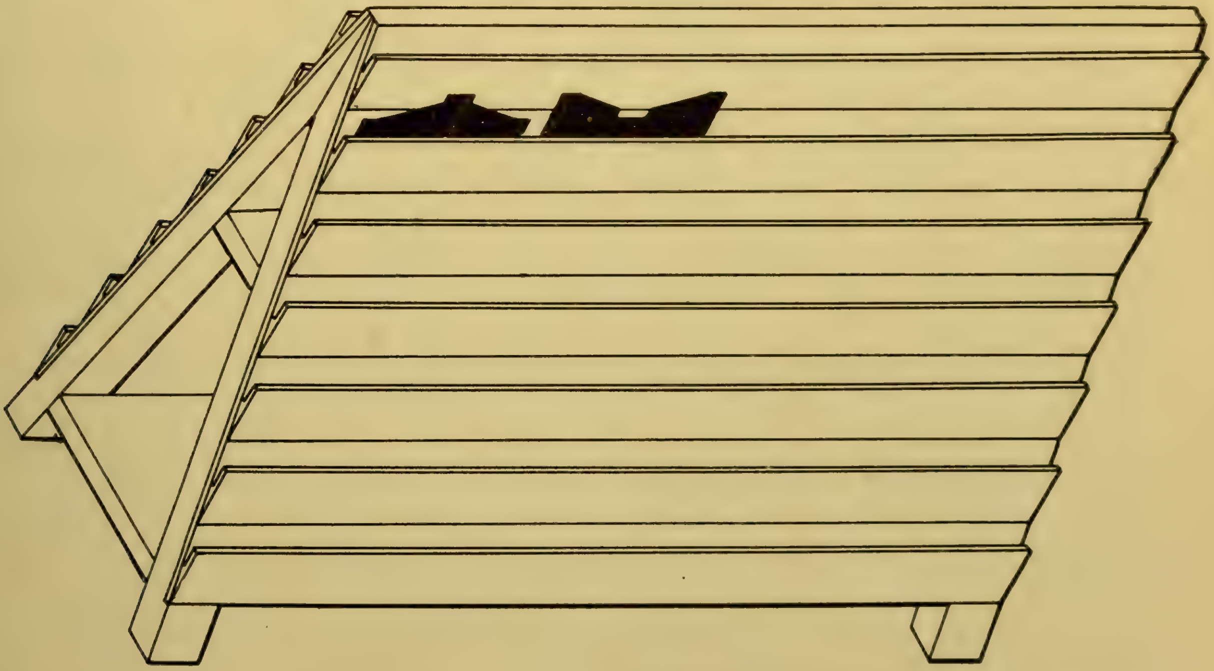
tailed construction is clearly shown on page 546.

Such an arrangement as this will accommodate eight or ten leaves, each of which is readily accessible, as the whole is upon a revolving stand.

The "Letter-Rack" system.—In engine shops it is frequently necessary to prepare sheet-iron gauges giving the shapes of such things as conical pistons, cylinder covers, etc., and these are apt to be somewhat awkward to store in an accessible position without occupying too much space. For this purpose I have found a kind of large letter-rack with double sides standing upon the floor, and about 5 feet 6 inches high to be very useful. This arrangement will be better understood by reference to a sketch on the facing page.

The three systems of storage mentioned will probably be found to accmodate the bulk of the small tools and jigs that need to be kept in a tool stores. It will be observed that the arrangements described cover the first four conditions that require to be met by the systems of storage, so we now have to show how the remaining conditions may be filled.

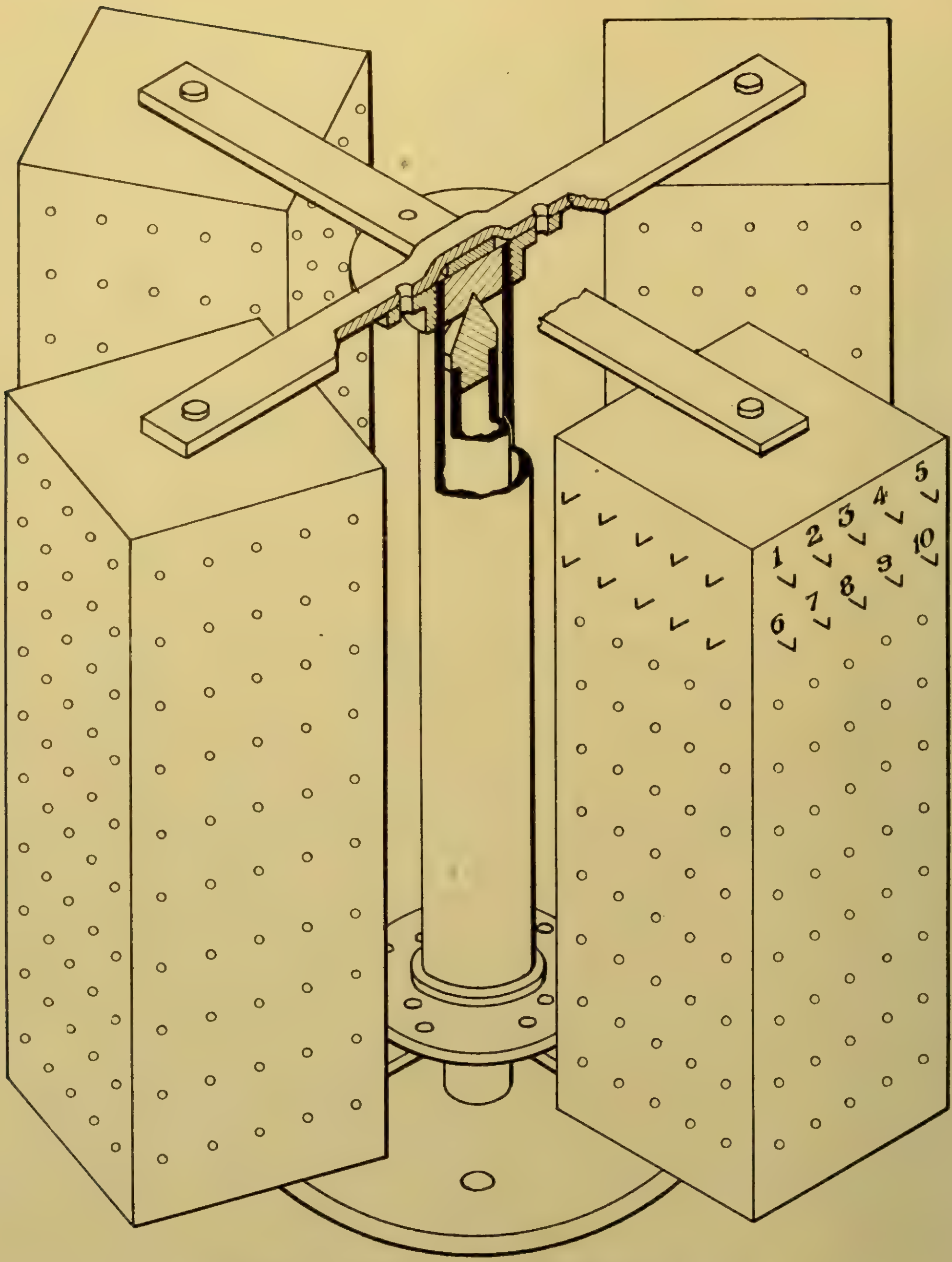
Any means of indicating where a tool has been taken, by a process of booking either upon slates, boards, or in books, will be found too clumsy for general use. A very satisfactory plan is to provide a number of metal checks stamped with the numbers by which the men are identified, say about eight or ten for each man. When a tool is given out from stores, one of these checks bearing the man's number is to be placed in the position from which the tool has been taken. The man is then known to possess that tool so long as his check there remains, and he is held responsible for its safe keeping. Some firms will give the checks into the hands of the men themselves, making them responsible for their safety, and for all tools obtained from stores with them. Thus if a man loses a check and another finding it should obtain a tool from stores by its aid, the man whose number is upon the check is held responsible. When this arrangement is followed a periodic inspection of checks must be made.



RACK FOR SHEET GAUGES, LETTER-RACK TYPE.

A better method is to provide for these checks to be kept within the stores upon a hook representing the man's number. Where a large number of checks have to be carried, such a fitting as that illustrated on the following page is very convenient.

In order to fulfill the last condition, it is necessary to have still another series of checks, somewhat larger and differing in shape, so that upon each may be stamped the name or other means of identifying a tool. One such check is marked for each tool and is kept with it upon its tray or leaf. When a workman obtains a tool the procedure then becomes for the stores keeper to take a numbered check off the man's hook, placing it in the position from which the tool is taken, and

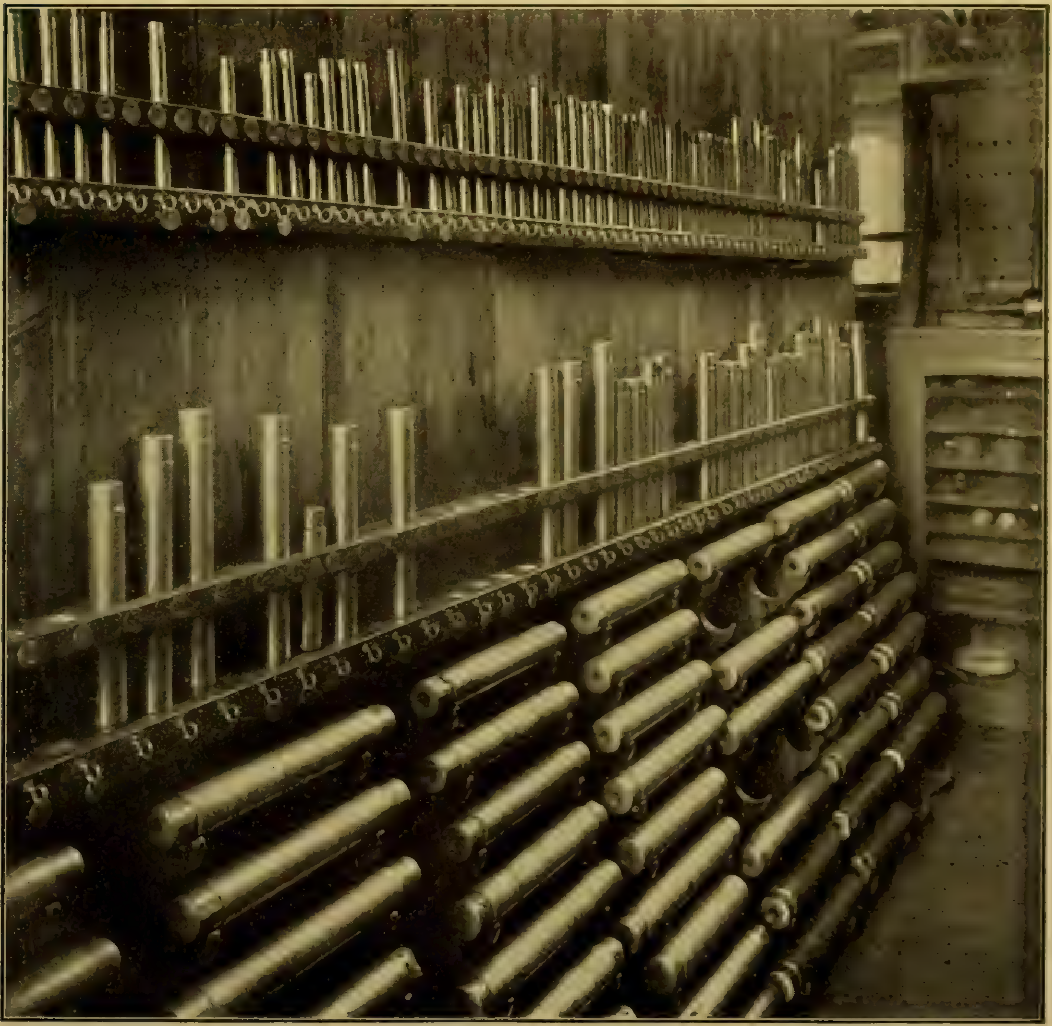


REVOLVING CHECK STAND FOR TOOL-ROOM USE.

at the same time the check corresponding to the tool is placed upon the man's hook. This double checking may be used for an additional purpose, for by its aid every week end the stores keeper can see and note what tools have not been returned to store, and at the same time state by whom the tool was obtained. It is a good plan to require that all tools should be returned to store before wages are paid, the stores keeper informing the cashier what men have broken the rule, a few minutes before pay time, and the cashier will then withhold the man's wages until the tool is found and taken to stores.

Returning once more to the functions of the tool room, it has been stated that their efficient fulfillment depends also upon the system of marking and the means for indicating to the workmen the tools to be used. These two things are very closely associated, because the marking of the tool is a means of identification and the tools to be used must be indicated upon the drawing to which the man works, unless dependence is to be placed upon memories of the men and foremen. The means of identification must be some system of numbering to avoid clumsiness, and moreover, it should simultaneously indicate the location, as thereby the storekeeper is assisted in finding the tool.

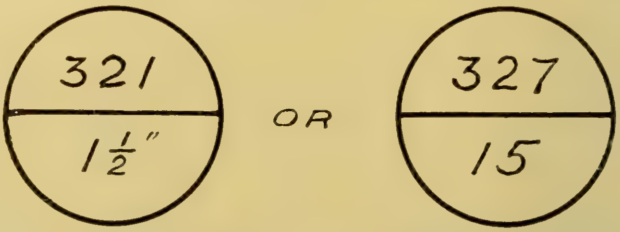
To operate a tool room satisfactorily at least one draughtsman should be associated with it, and he should keep a register of all tools



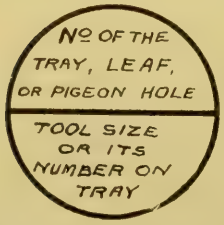
MANDREL RACK, TOOL STORES OF THE LINK BELT ENGINEERING CO., NICETOWN, PHILADELPHIA.

Each mandrel has its special place, marked with the size on the round brass plate. When a mandrel is delivered to a workman, the man's check is hung upon the corresponding hook. The circular form of the hook secures the check against all danger of dropping or being brushed off.

that are made. He should control in large measure the locating of tools in the stores, so that similar tools either actually made or anticipated may be grouped together and numbered by their sizes. When using the tray system it will be found convenient to number each tray and to number independently each tool upon the tray. Thus ordinary tools, such as taps, reamers, gauges, etc., may be considered to be numbered by their size, and other tools whose size cannot be so used may be plainly numbered. The full tool identification mark may then be such as follows:—



The interpretation of the symbol as is shown at the left. The number above the bar within the circle indicates the tray, leaf, pigeon hole, drawer, or place where the tool is kept, and the number below gives the size or number of the actual tool of the group upon the tray.


No OF THE TRAY, LEAF, OR PIGEON HOLE
TOOL SIZE OR ITS NUMBER ON TRAY

It would be part of the natural duties of the draughtsman above referred to, to mark upon each drawing of work to be made, before it is issued to the shops, the tool identification marks.

This provides another precaution—that tools are actually made suitable for the job—for should the draughtsman find no suitable tool to be in existence, he would prepare a sketch and have one made in readiness, issuing with the sketch the marks to be placed upon the tool when made.

A scheme of operations based upon the suggestions contained in this article will be found to make a tool room fulfill its various functions and become a live, active, and indispensable part of the establishment, and not the least valuable point is that brought out at the conclusion; for it secures the much needed connection between the draughting office, tool room, and the workman.

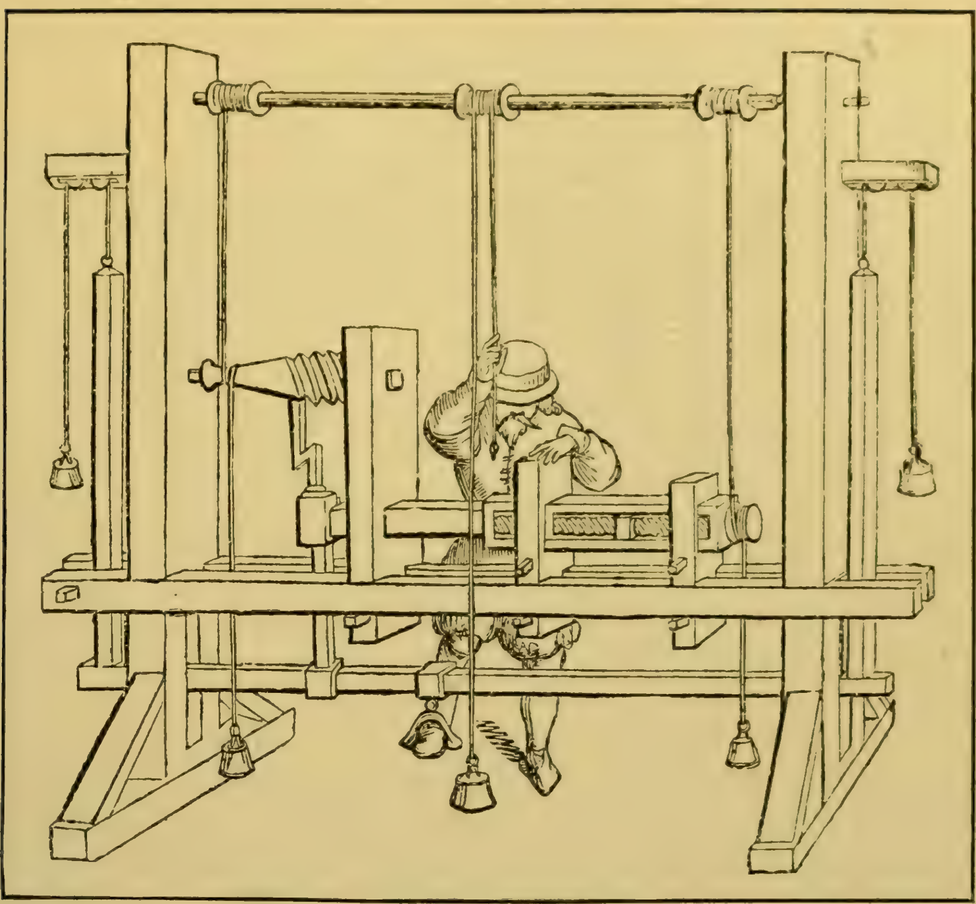


FIG. I. SCREW-CUTTING LATHE BUILT IN FRANCE IN 1659.

ADVANCED PRACTICE IN ECONOMICAL METAL CUTTING.

By Charles Day.

One of the most experienced shop managers of the time says machine-shop practice is changing so fast that "the workman of the year 1900, if kept out of touch with current developments, would make a poorer showing in the shop of 1915 than the workman of George Stephenson's time would in the average shop of today." Mr. Day reviews concisely the great factors of this change. A detailed discussion of their practical bearings, by Mr. Hess, will form an important feature of THE ENGINEERING MAGAZINE for some months to come.—THE EDITORS.

DURING the past few years we have heard much of the high-speed steels, modern machine equipment, and motor drive, and there is no longer any doubt as to their great value as a means of reducing cost and extending manufacture. The desired results can be attained, however, only when the equipment is in the hands of those who fully realize its possibilities and the relation that each factor bears to the problem as a whole.

The modern machine shop implies more than buildings and machinery, as the labor conditions and system of shop management in use influence the type of equipment and govern the efficiency that may be attained. At present, growth is so rapid that the only way thoroughly original and valuable results may be reached is by concentrating on a single detail, studying its relation to all other factors and, by persistent investigation and thought, arriving at the true facts. A general knowledge, however, is of great value to the worker in assisting him to see the true bearing of the specialty upon which his energies are being expended.

We must ever bear in mind that the machine shop in all its details is but a means to an end, and the general problem starts with the first conception of the article to be manufactured. The value to the designer of a thorough knowledge of shop practice cannot be over-estimated, for while the efficient plant can perform *operations* at a minimum cost, the aggregate cost of a job depends on the amount and character of the machining.

The high-speed steel, rapid-reduction lathe, and motor drive, cannot be intelligently considered separately, nor should a plant be designed and equipped without knowledge of the type of management to be employed. Rather than describe only modern equipment, I will first briefly outline the historical development of machine-shop apparatus, for it is only in the light of this information that we can have a full realization of the modern shop.

A most interesting lecture by Mr. H. F. J. Porter, on the "History of the Art of Forging," outlines this most important subject from its early beginning, about 3,000 years B. C., to the present day. In this connection, however, the work of Benjamin Huntsman, who labored more than one hundred and sixty years ago to produce a high-grade crucible steel, marks the first great step forward. Years were devoted by him to investigation and experiment, resulting in a crucible carbon steel which for many years held its own in point of quality and uniformity. Later, Messrs. Heath and Mushet, by the addition of manganese, produced a so-called air-hardening steel of greater efficiency, and the brand known as "Sheffield Mushet" held the foremost position as a high-speed steel of great uniformity until the discoveries made a few years ago by Messrs. Taylor and White at the Bethlehem Steel Works.

Those who have followed the growth of the machine shop during the past ten years, and, in addition, are familiar with its early history, find so many landmarks of almost epoch-making importance that it is difficult to say just when the greatest strides forward were made.

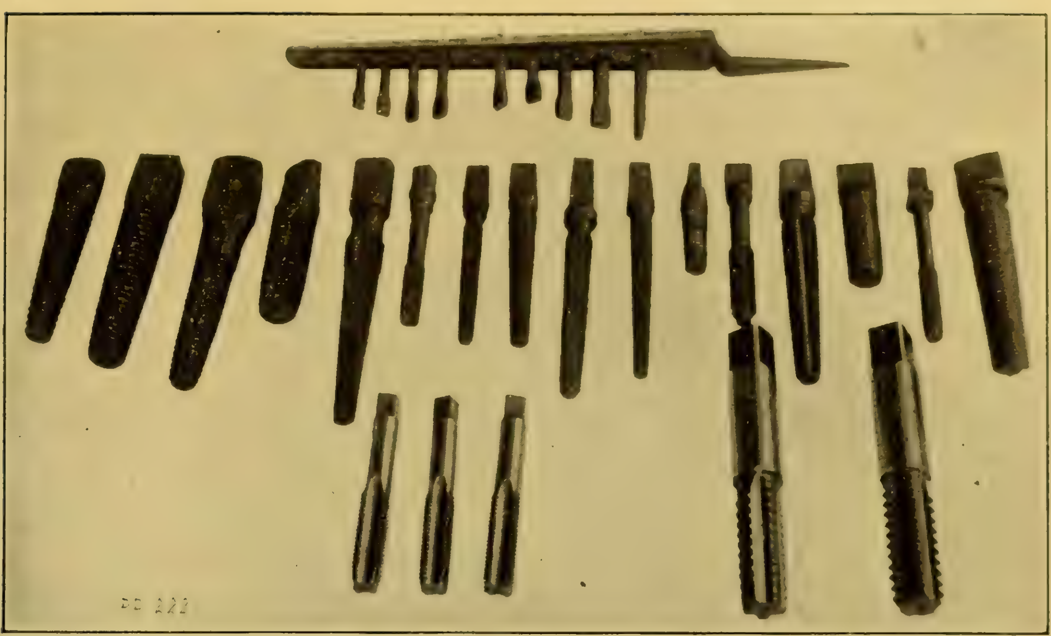


FIG. 2. COLLECTION OF TAPS, SHOWING EVOLUTION FROM THE OLDEST TO THE MOST MODERN TYPE.

As a result of the work of Taylor and White, however, the achievements of the modern shop are known to even those not directly engaged in this line, through the impetus received in all its details as a result of their invention. Intelligent direction of shop work has been the greatest lesson taught by Mr. Taylor, for no matter how great his discovery of the treatment of steel, that, in itself, is but secondary as compared with the indirect influence it has exerted in every branch of manufacture. It has awakened the engineering world to the possibilities of intelligent effort as opposed to slip-shod methods—an expression none too strong to describe conditions found on every hand a few years since.

Like most great discoveries, the Taylor-White process was the result of a most painstaking investigation, but can now be expressed in the simplest terms. The term "high-heat treatment" is probably used hundreds of times each day, but in the few years that have elapsed the pioneering work at the Bethlehem Steel Works has been forgotten by many. It is to Fred Taylor and his associate, Maunsel White—and to them primarily—that we are indebted for cutting tools that enable us to remove metal from two to three times as rapidly as was formerly possible. Taylor's work in shop management has been equally revolutionary although little understood by many. We can well say of his work, as Agassiz has said of Humboldt:—

> "The fertilizing power of a great mind is truly wonderful, but as we travel further from the source, it is hidden from us by the very abundance and productiveness it has caused."

Mr. William Fairbairn, in an address before the British Association of Manchester in 1861, stated that when he first became acquainted with mechanical engineering, about 1804, there were no self-acting tools; everything was executed by hand. There were neither planing, slotting, nor shaping machines; and the whole stock of an engineering or machine establishment might be summed up in a few lathes, drills, and boring machines of rude construction.

It will thus be seen that the year 1904 is quite near to the one hundredth anniversary of the first impetus given to the development of wood and metal-working machinery, which has resulted in the production today of apparatus such as the early pioneers never dreamed of. There are a number of men whose names are so closely associated with the development of the machine shop that I feel they should be mentioned here. The work of Savery and Newcomen

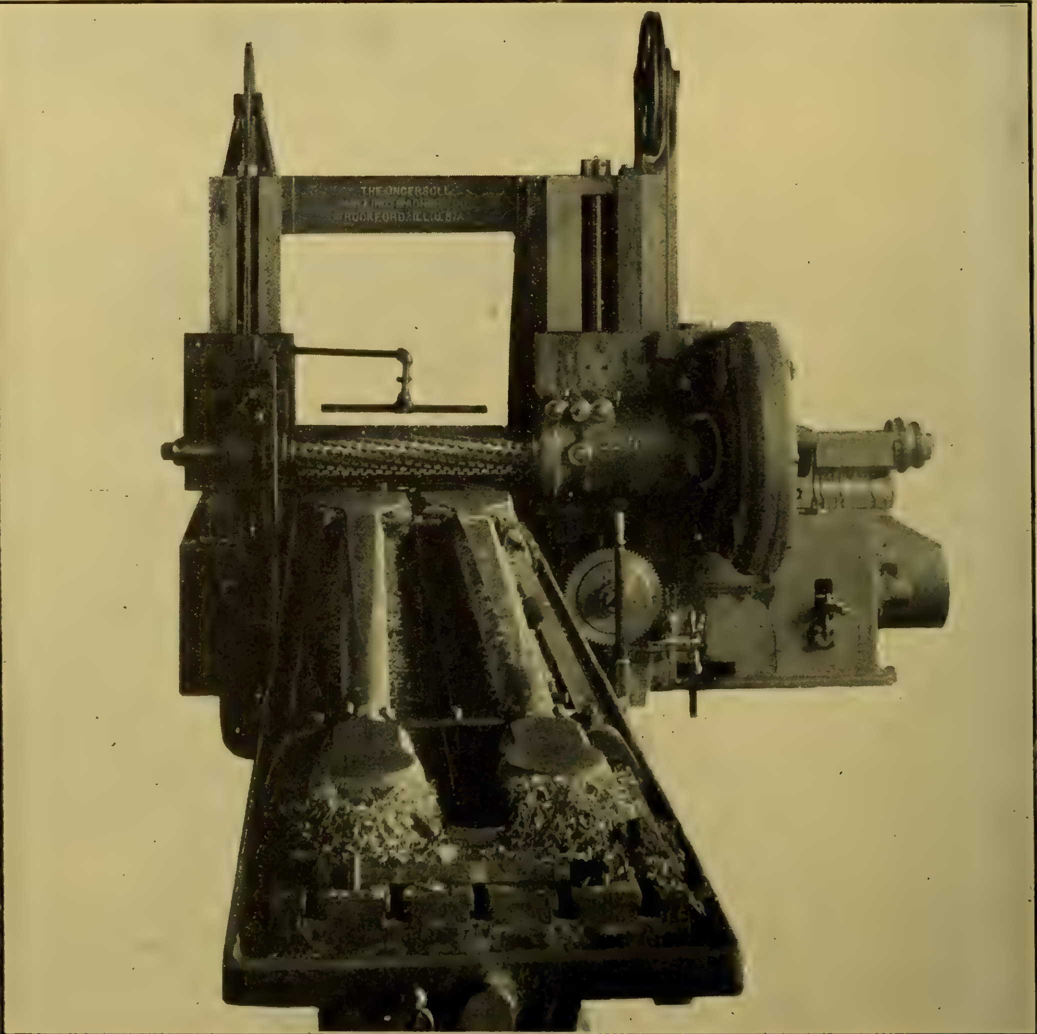


FIG. 3. A MODERN HEAVY MILLING MACHINE.

Horizontal-spindle milling machine for heaviest class of slabbing work, slabbing two large Corliss-engine connecting rods. Ingersoll Milling-Machine Co., Rockford, Ill.

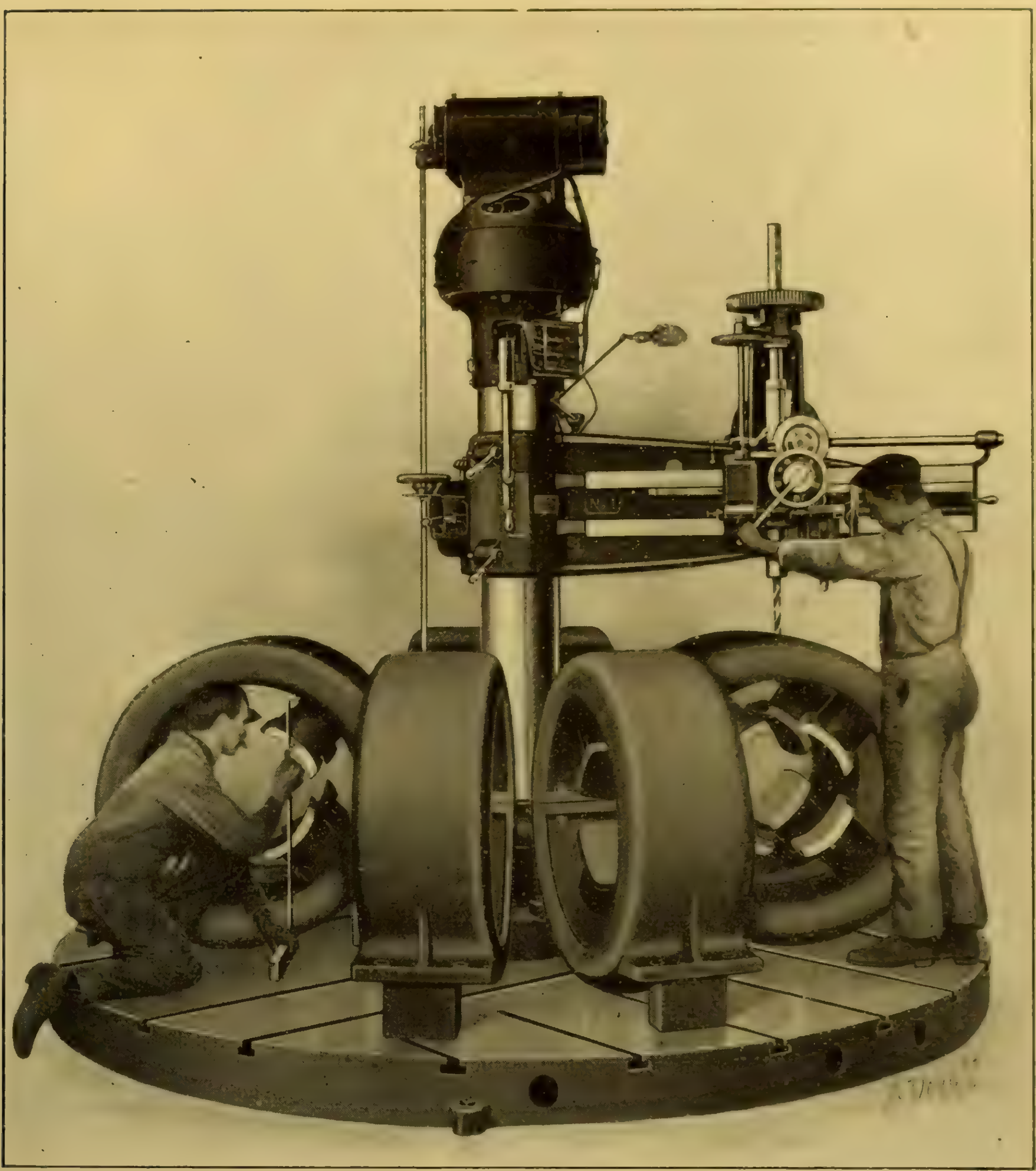


FIG. 4. AN EXAMPLE OF THE MULTIPLE SETTING BASE.

Bickford Drill & Tool Company's radial drill with circular base in the shops of the Crocker-Wheeler Co.

led up to that of James Watt; Murdock to the Stephensons'; and Maudslay to Clement, Roberts, Nasmyth, and Whitworth.

Watt's engine was so much in advance of the mechanical capabilities of the age that it could be manufactured only with the greatest difficulty. The cylinders, at the start, were not bored at all, and even after Watt became associated with Boulton and was assisted by the latter's best mechanics, the opinion was expressed by many that his engine would never be brought into practical use on account of the difficulty of getting its various parts manufactured with sufficient precision. It seem almost incredible to engineers of today that Watt should have had so few facilities at his command.

It is an interesting study of the subject of environment to trace the lives of the pioneers of machine-tool industry. In the workshop of Joseph Bramah was an apprentice—Henry Maudslay, born in 1771, to whom the machine shop of today owes more than any other of its founders. The invention of the slide rest on the lathe is now universally conceded to him, and, as a result of this, the other machine tools with which we are familiar were rapidly developed.

The lathe can be traced back many hundred years, one of the earliest types being shown at the Buffalo fair. A Mussulman squatted on the ground manipulating with astonishing dexterity this primitive machine but a few inches high—two stakes, a wedge adjusting the crude centres, one hand plying a bow to drive the work, with the foot acting as a rest and guide to the tool in the other hand. The slide rest, however, immediately revolutionized lathe work, not only assuring much greater accuracy than formerly, but reducing cost by making it possible to take heavier cuts. Like other great inventions, it had to encounter much ridicule; for a time it was spoken of as "Maudslay's go-cart"; but its advantages were so decided that it gradually became established. Very shortly after its invention, modifications of the lathe, the planer, slotter and numerous other tools came into use. Nearly all of the machines described below can, therefore, be traced to the workshops of the well-known firm of Maudslay, Field, & Company, established 1810.

The earliest screw lathe of which I have been able to find record bears date of 1659, and is illustrated in Figure 1. A practical machine for cutting screw threads was not developed, however, until Maudslay gave this matter his attention. Previous to his time screws were, for the most part, cut by hand, by means either of a file or a chisel, according to their size. Every bolt, with its corresponding nut, had, of course, to be marked, and the complications arising from this cause can readily be imagined. In Maudslay's system of screw-cutting machinery we have the foundation of all that has since been done in this important branch of machine construction, in which he was so ably followed by Joseph Clement and Joseph Whitworth.

To illustrate the crude condition of affairs existing but recently, I have had a photograph (Figure 2) made of a series of old taps that I have collected. The earliest types worked on the principle of the swage, and no means were provided for clearance or lubrication. Step by step the modern tap has been developed, nearly every intermediate step being illustrated. It was sometime before the swaging principle gave way to a cutting action, and it would, indeed, be hard to find a series of tools defining more clearly the evolution undergone through a term of years. On the one hand we have the hand made tool—simply a taper screw; on the other the modern stagger-tooth tap made by machinery to the greatest accuracy required.

Joseph Clement, in 1825, built one of the first planers, designed to handle work up to 6-feet square. Clement's work was ably followed by Whitworth, who established the British screw standard now in general use in England, as well as the micrometer and surface plate.

William Fairbairn, born in 1787, revolutionized the transmission of power by shafting. Square, cast-iron shafts were almost universally in use when he entered this field, as well as pulleys and boxes of the crudest character. To Mr. Fairbairn we owe our present system of shafting and pulleys, and the importance of his work in connection with the development of the machine and cotton industries can scarcely be over-estimated.

I have only attempted to touch upon the most important historical facts in connection with the development of machine-shop equipment. The rapid growth of this industry as a result of the work of those pioneers referred to is known to all, but in the years to come the present time will probably stand out clearly as the period of general awakening to the possibilities of intelligent work.

Previous to the investigation conducted by Mr. Fred W. Taylor, at the Bethlehem Steel Works, practically no data of value were available relative to the laws governing speed, feed, and depth of cut for different materials, nor have later investigators obtained results approaching his in so far as their usefulness is concerned.

Data of this kind considered strictly from the commercial side are of value only in so far is they lend themselves to the production of better machines, or the more efficient operation of those in use. Just as the machinist by means of the Warner cut meter can now know at all times the cutting speed as easily as he can tell the time of day from his watch, so the Taylor-Barth slide rules make the determination of cutting speed, depth of cut, etc., the simplest matter. Either problem could be worked out mathematically, but such calculations are not practicable in daily shop work.

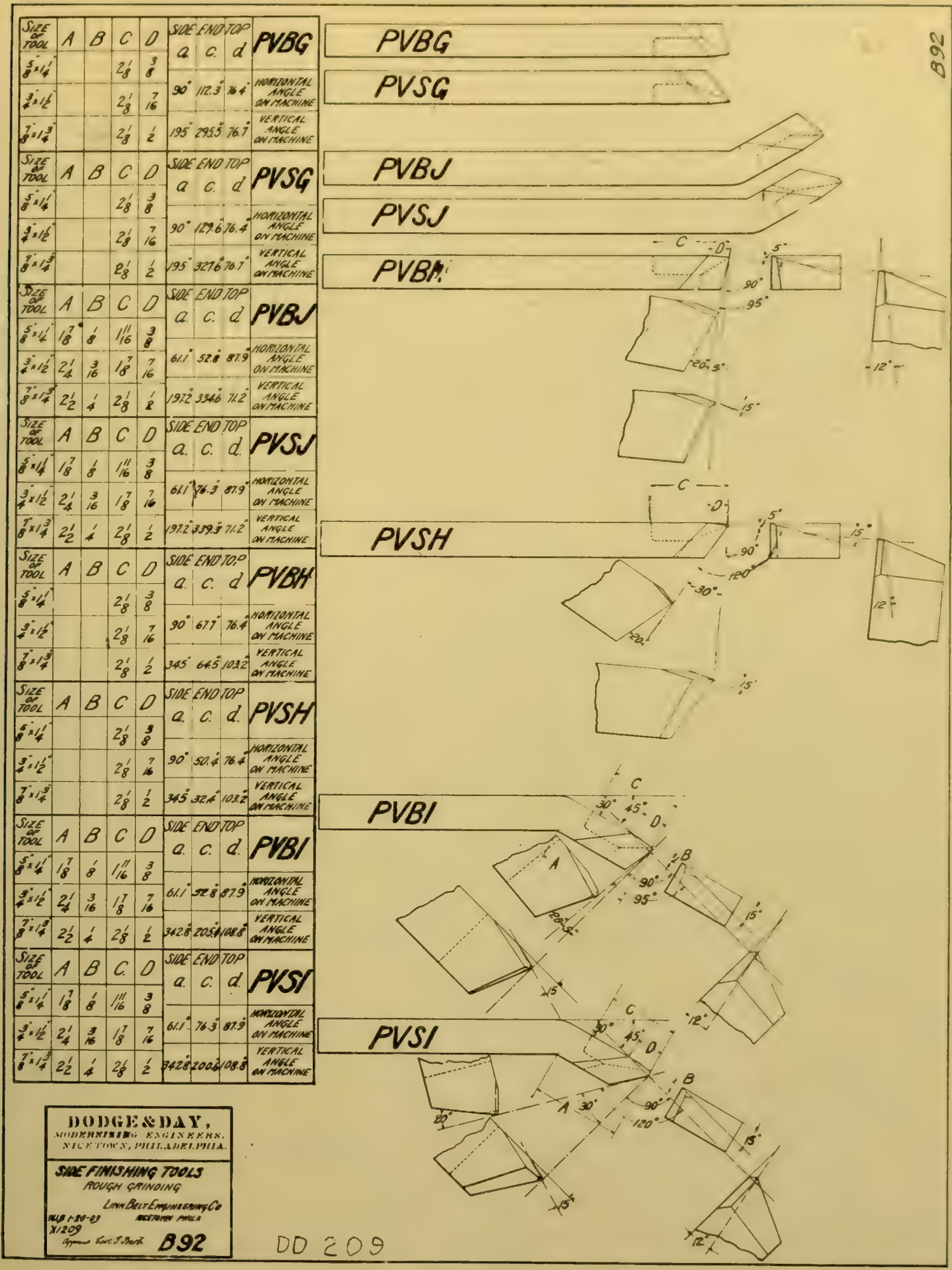
There are numerous makes of tool steel upon the market of almost equal efficiency, and much better results would be obtained by the average shop if their characteristics were more clearly understood. The need of a high heat (that is, a heat at which the point of the tool can be readily nicked by pressure from a small iron rod), of care in grinding, proper provision for clamping at tool post, and finally, a knowledge as to the work the tool should be capable of, are fully appreciated by but few. Even today many shops permit their workmen to grind their own tools, but this practice is unquestionably bad under any circumstances. This brings us to one of the most important factors in connection with the modern shop—I refer to the tool department, where the cutting tools of all kinds are not only cared for, but the jigs, templets and gauges designed and made. While economies that may result if parts are made in sufficient quantity are generally understood, there are a number of large concerns which still fail to appreciate what is being accomplished along these lines.

One of the most able shop managers, whose experience extends through the shops of the United States, Germany and Great Britain, says, in part:

> "Indeed, the essential of economic production next to the use of the best modern tools lies in the separation of the preparation and care of tools from their operation. A limited number of highly skilled and highly-paid tool makers should be entrusted with the care of the machines and the preparation and to the tending of machines. In this way the cost of the skilled labor is divided among so many machines as to form but a small element in production cost, and the great bulk of the labor which bears a direct relation to the product may be performed by cheaper men."

Mr. John Ashford's article appearing in this issue considers the tool room in detail. The model tools illustrated on page 538 placed alongside the tool-room window so that the workman can designate those he requires, are very necessary if the cutting tools are to be used to the best advantage. Much experimenting has been done to determine the best forging and grinding angles for various conditions of operation. In connection with the installation of the Taylor system of management in the shops of the Link-Belt Engineering Company, this matter has been gone into fully, Figure 5 being a photograph from one of our tracings and giving complete data relative to side-finishing tools. In this way each type of tool has been worked out, much experimenting being required to arrive at the necessary data. Many tools are forged under the steam hammer, bending being facilitated by dies designed for that purpose.

Time brings many changes, and success at one period very often results from radically different causes from those which produced success at another. One hundred years ago there were but a few competent machinists, and fewer establishments where good work could be done. The demand for steam engines and cotton machinery was great, so that such men as Maudslay, Clement, Nasmyth and Fairbairn could keep their shops busy even though their cost of production was extremely high. These men, however, were usually in the shop a greater part of their time, and personally superintended the



SIZE OF TOOL	A	B	C	D	SIDE a	END c	TOP d	PVBG
5/8"×1 1/4"			2 1/8	3/8				
3/4"×1 1/2"			2 1/8	7/16	90°	112.3°	76.4°	HORIZONTAL ANGLE ON MACHINE
7/8"×1 3/4"			2 1/8	1/2	195°	295.5°	76.7°	VERTICAL ANGLE ON MACHINE

SIZE OF TOOL	A	B	C	D	SIDE a	END c	TOP d	PVSG
5/8"×1 1/4"			2 1/8	3/8				
3/4"×1 1/2"			2 1/8	7/16	90°	129.6°	76.4°	HORIZONTAL ANGLE ON MACHINE
7/8"×1 3/4"			2 1/8	1/2	195°	327.6°	76.7°	VERTICAL ANGLE ON MACHINE

SIZE OF TOOL	A	B	C	D	SIDE a	END c	TOP d	PVBJ
5/8"×1 1/4"	1 7/8	1/8	1 11/16	3/8				
3/4"×1 1/2"	2 1/4	3/16	1 7/8	7/16	61.1°	52.8°	87.9°	HORIZONTAL ANGLE ON MACHINE
7/8"×1 3/4"	2 1/2	1/4	2 1/8	1/2	197.2°	334.6°	71.2°	VERTICAL ANGLE ON MACHINE

SIZE OF TOOL	A	B	C	D	SIDE a	END c	TOP d	PVSJ
5/8"×1 1/4"	1 7/8	1/8	1 11/16	3/8				
3/4"×1 1/2"	2 1/4	3/16	1 7/8	7/16	61.1°	76.3°	87.9°	HORIZONTAL ANGLE ON MACHINE
7/8"×1 3/4"	2 1/2	1/4	2 1/8	1/2	197.2°	339.5°	71.2°	VERTICAL ANGLE ON MACHINE

SIZE OF TOOL	A	B	C	D	SIDE a	END c	TOP d	PVBH
5/8"×1 1/4"			2 1/8	3/8				
3/4"×1 1/2"			2 1/8	7/16	90°	67.7°	76.4°	HORIZONTAL ANGLE ON MACHINE
7/8"×1 3/4"			2 1/8	1/2	345°	64.5°	103.2°	VERTICAL ANGLE ON MACHINE

SIZE OF TOOL	A	B	C	D	SIDE a	END c	TOP d	PVSH
5/8"×1 1/4"			2 1/8	3/8				
3/4"×1 1/2"			2 1/8	7/16	90°	50.4°	76.4°	HORIZONTAL ANGLE ON MACHINE
7/8"×1 3/4"			2 1/8	1/2	345°	32.4°	103.2°	VERTICAL ANGLE ON MACHINE

SIZE OF TOOL	A	B	C	D	SIDE a	END c	TOP d	PVBI
5/8"×1 1/4"	1 7/8	1/8	1 11/16	3/8				
3/4"×1 1/2"	2 1/4	3/16	1 7/8	7/16	61.1°	52.8°	87.9°	HORIZONTAL ANGLE ON MACHINE
7/8"×1 3/4"	2 1/2	1/4	2 1/8	1/2	342.8°	205.4°	108.8°	VERTICAL ANGLE ON MACHINE

SIZE OF TOOL	A	B	C	D	SIDE a	END c	TOP d	PVSI
5/8"×1 1/4"	1 7/8	1/8	1 11/16	3/8				
3/4"×1 1/2"	2 1/4	3/16	1 7/8	7/16	61.1°	76.3°	87.9°	HORIZONTAL ANGLE ON MACHINE
7/8"×1 3/4"	2 1/2	1/4	2 1/8	1/2	342.8°	200.6°	108.8°	VERTICAL ANGLE ON MACHINE

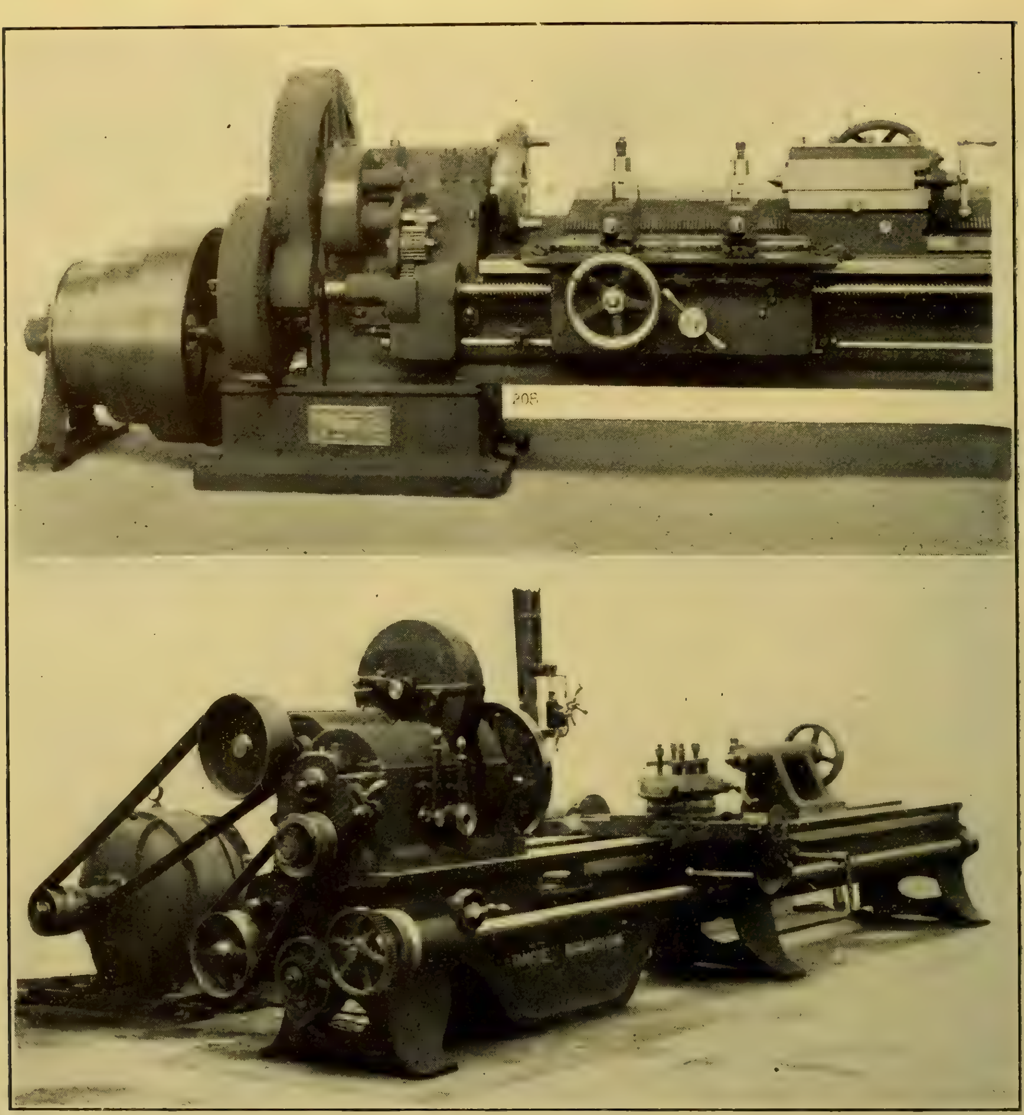
DODGE & DAY,
MODERNIZING ENGINEERS,
NICETOWN, PHILADELPHIA.

SIDE FINISHING TOOLS
ROUGH GRINDING
Link Belt Engineering Co
Nicetown Phila
[illegible] 1-30-09
X1209
Approved Carl J. Barth
B92

DD 209

FIG. 5. AN ILLUSTRATION OF THE DEVELOPMENT OF SIDE-FINISHING TOOLS.

work of each man. But as machine tools came into general use, and could be readily obtained in the open market, competition began to play an important part, and the need of specializing was immediately felt. In this connection we do not have to go back many years, for it is clearly illustrated in the machine-tool business in the United States. Twenty-five years ago practically all the machine tools were made in New England, each manufacturer making, as a rule, all the



FIGS. 6 & 7. MODERN HIGH-SPEED LATHES. SHOWING STUDY OF RIGIDITY OF DESIGN, CONVENIENCE OF OPERATION, AND ADEQUATE POWER.

The upper one is a rapid reduction lathe by Lodge & Shipley, Cincinnati, Ohio. The lower is a modern motor-driven lathe by the Tangye Tool & Electrical Co., Birmingham, England.

various types of apparatus required by the average shop. Before long the need of specializing became apparent, as it was found impossible to manufacture at low cost unless a sufficient quantity of the same line of product were made. The machine-tool builders of the middle west started in business with a realization of this fact and designed their shops accordingly, concentrating all their energies on one type of tool. These specialized concerns are especially well equipped for building machines to meet the requirements of the modern steels.

After scientific investigation had evolved the high-speed tool it would be unreasonable to suppose that machines formerly in use would be fitted for this new duty. At first manufacturers were slow to realize the extent of modifications necessary, but within the past two years their attitude has completely changed. We find in almost every issue of our technical papers machines of modified design suited for specific conditions. The manufacturer realizes that he must now adapt his machines to fulfil certain conditions at the tool, and the need of an experimental department to determine the characteristics of the latter is now generally conceded.

Enormous planers have recently been designed to take work up to 12-feet square through the housings. Think of the surprise of Joseph Clement if he could see such a machine, with a tool in each head, removing metal at the rate of possibly two or three tons an hour. Numerous schemes have been resorted to to do away with the troublesome shifting of belts, but so far they have not met with general adoption. I refer to the magnetic and pneumatic clutches which are now used in a number of shops. Many suppose that the modern steels cannot be operated at as high cutting speeds in a planer as on a lathe, but this is not the case. If the tool be prevented from dragging on the return the action is similar to that of a saw with inserted teeth. I have

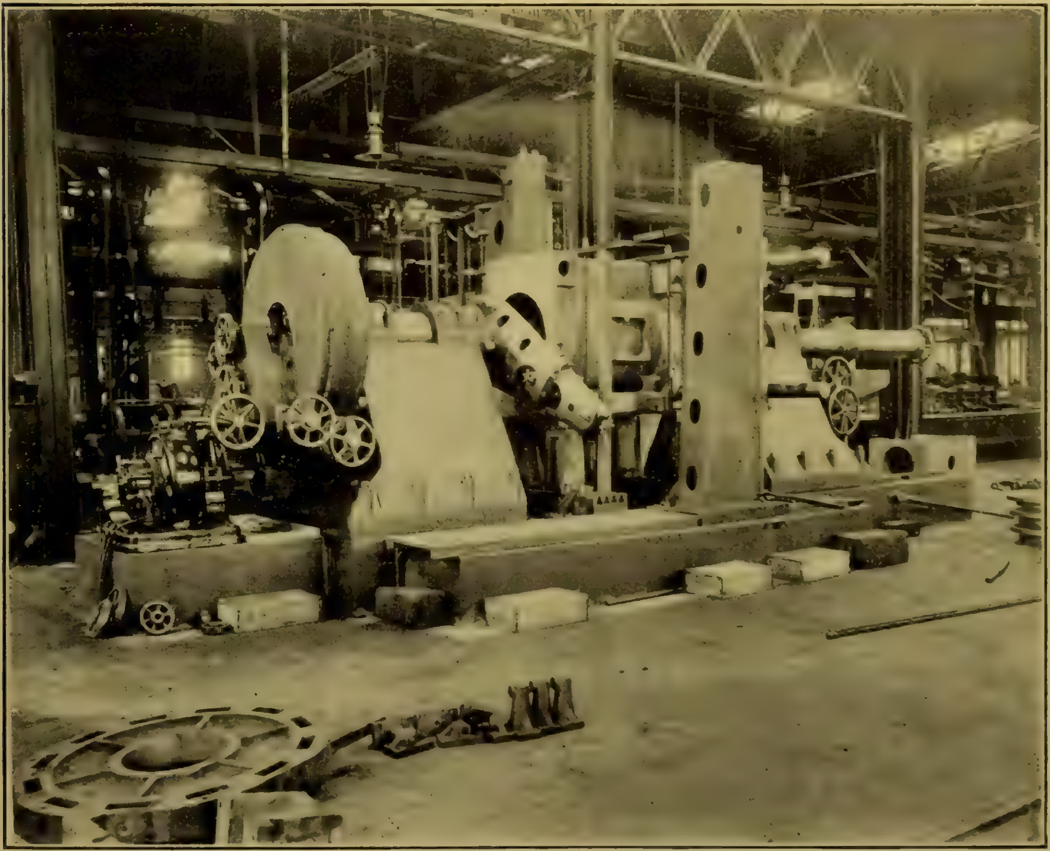
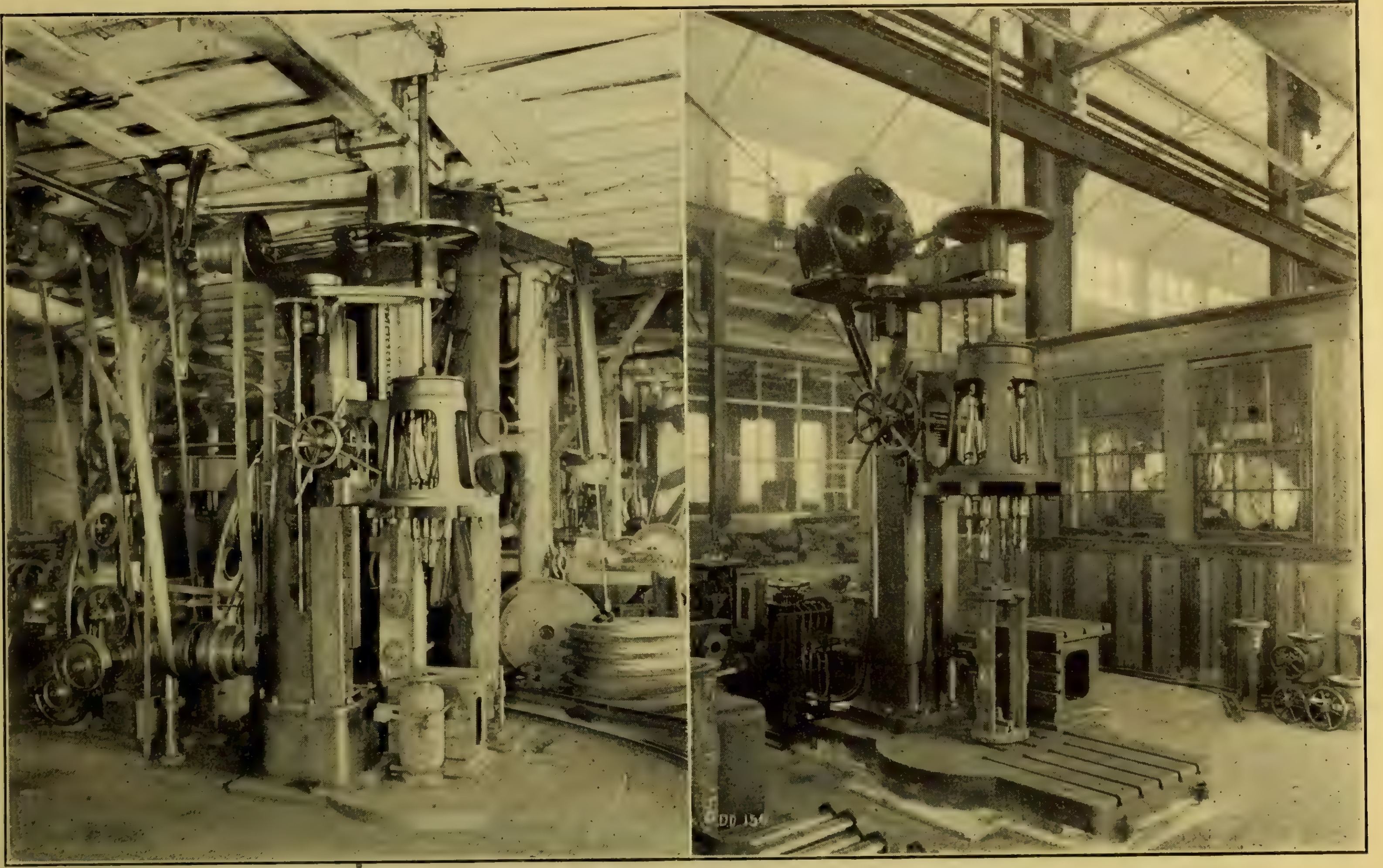


FIG. 8. CORLISS-CYLINDER-BORING MACHINE BUILT BY THE NILES-BEMENT-POND CO. AND INSTALLED IN THE SHOPS OF THE HOOVEN-OWENS-RENTSCHLER CO., HAMILTON, OHIO.

Bores the cylinders and valve ports and faces the flanges at one operation. Motor driven and very rugged in design, so as to use high-speed steels to the best advantage.



FIGS. 9 & 10. ILLUSTRATING INCREASE OF MACHINE-TOOL CAPABILITIES BY INTRODUCTION OF ELECTRIC DRIVING.

Bausch multiple-spindle drill; on the left, as operating in the old plant of the Jeanesville Iron Co., Jeanesville, Pa.; on the right, the same tool equipped with Crocker-Wheeler motor in the new shops of the company.

seen the Taylor-Newbold saws running at 260 feet cutting speed, with an advance of 8 inches per minute, cutting off steel bars (15 point carbon). Reversing a planer at high speeds is not an easy matter, although it is now being successfully accomplished.

More revolutionary measures have been necessary in connection with the design of milling and drilling machines, as milling cutters and twist drills have been made of air-hardened steel only since the discovery of the high-heat treatment, while for lathe work, the Mushet tool was an intermediate step between carbon and high-speed steels.

I recently had the pleasure of reviewing some tests made upon blue-chip milling cutters, by Wheelock & Lovejoy of Boston, and the great life of the tools in addition to the higher cutting speeds and feeds are remarkable. One form cutter used for milling hard, unannealed tool-steel forgings milled 9,900 pieces without injuring the cutting edge in the slightest degree. The carbon tool-steel cutter failed completely after machining 100 pieces.

One of the most important features in connection with the modern shop is the motor drive, which, in so many ways, has contributed to more economical manufacture. The first introduction of the motor into the machine shop was about 1883—but 20 years ago. It was estimated in January, 1903, that in the United States alone, the motors operating in manufacturing establishments would aggregate at least 350,000 horse-power, and this figure has grown so rapidly since that any estimate I might make would probably be wide of the mark.

Today there is no longer any question as to the desirability of electrical transmission in manufacturing establishments. It is only the details that are still open to discussion among engineers. To describe the various types of apparatus on the market, or enlarge on the numerous advantages that should follow their use would require a separate paper; but Figures 9 and 10 will serve to illustrate practically all the advantages of the motor drive, namely:—ease with which material may be handled on account of location of the machine under overhead crane; adequate power at all times; sufficient number and range of speeds; ease of operation, etc.

The Crocker-Wheeler Company were among the first concerns to realize fully the possibilities of the individual drive, and the apparatus which they have developed has been designed primarily to meet shop requirements. The motor also makes possible the use of the portable tool in a way that was not practicable before its adoption. Figure 11 illustrates a bed-plate in the works of the Westinghouse Electric & Mfg. Co., at Pittsburg, Pa., where a number of portable tools are at work on a dynamo field frame. A gang of men especially trained in this line have charge of bolting down the work and machines, and as a number of tools can frequently be working on the same piece a marked saving of time is therefore effected.

Figure 12 shows an interior view of the main machine shop of the Jeanesville Iron Works Co., and illustrates the principal features of the modern shop, such as the overhead traveling electric crane, industrial railway, electric operation of machine tools, and the good natural light.

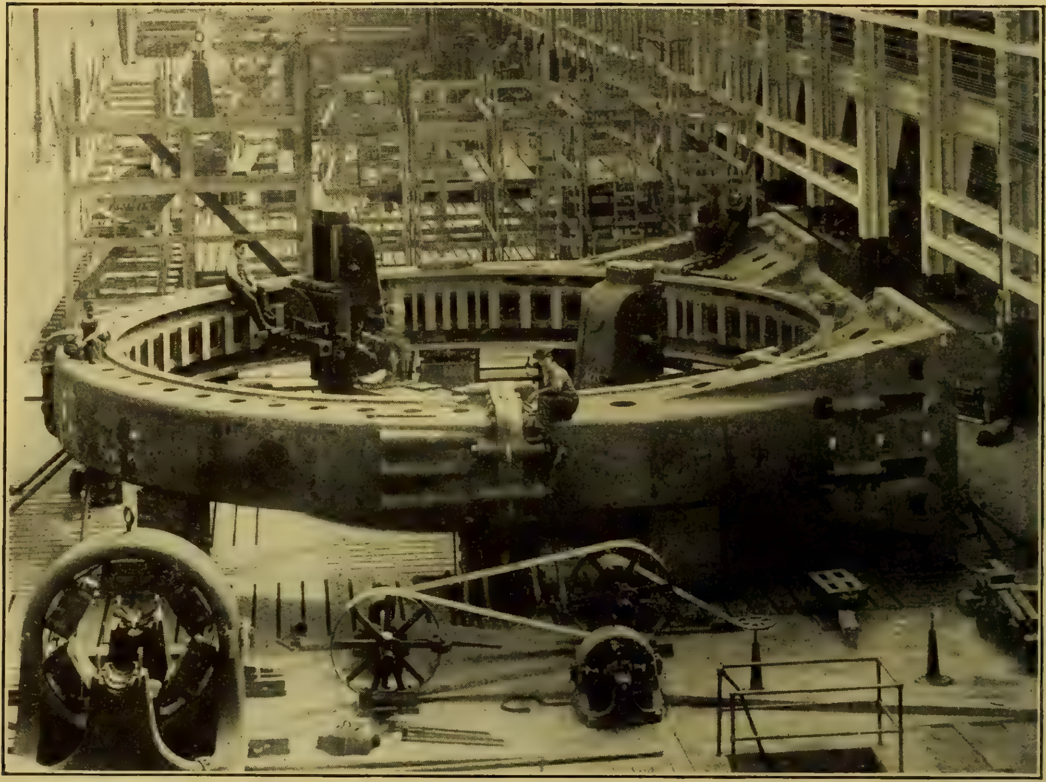


FIG. II. BED-PLATE FLOOR FOR PORTABLE TOOLS ON HEAVY WORK; NEW MACHINE SHOP OF THE WESTINGHOUSE ELECTRIC & MFG. CO., PITTSBURG, PA.

The tools thus far considered have not been of the automatic type, although designed for special duty. There is the ordinary engine lathe designed for a general line of work; the engine lathe of special design, adapted for doing just one class of work; and, again, the full automatic lathe. Automatic machinery is not of recent origin, but the perfection recently arrived at is, indeed, astonishing. The lathe illustrated by Figure 13 is one of the latest types built by Pratt and Whitney, having a disc magazine, and is capable of handling a very miscellaneous line of work. The air-closing mechanism on the chuck allows considerable variation in size of work, doing away with sorting, which was heretofore necessary. I recently saw one of these machines fitted with a gravity magazine machining sewing-machine hand wheels. They were turned all over, bored, finished, and finally dropped into a suitable box in 4½ minutes. One man and a helper attended twelve of these machines. I would not venture to say how long it would take to complete this job if machined on an engine lathe of the ordinary type.

As Mr. Norton deals specifically with the subject of grinding elsewhere in this number I need make but passing reference to the subject here. Much has been accomplishd toward more accurate and cheaper product. The grinding machine in its various forms is adapted to the roughest or finest work, and as a result of the makers' investigations machines have been developed that have entirely superseded the lathe for finishing certain kinds of work. The lathe of the future will be used largely for roughing.

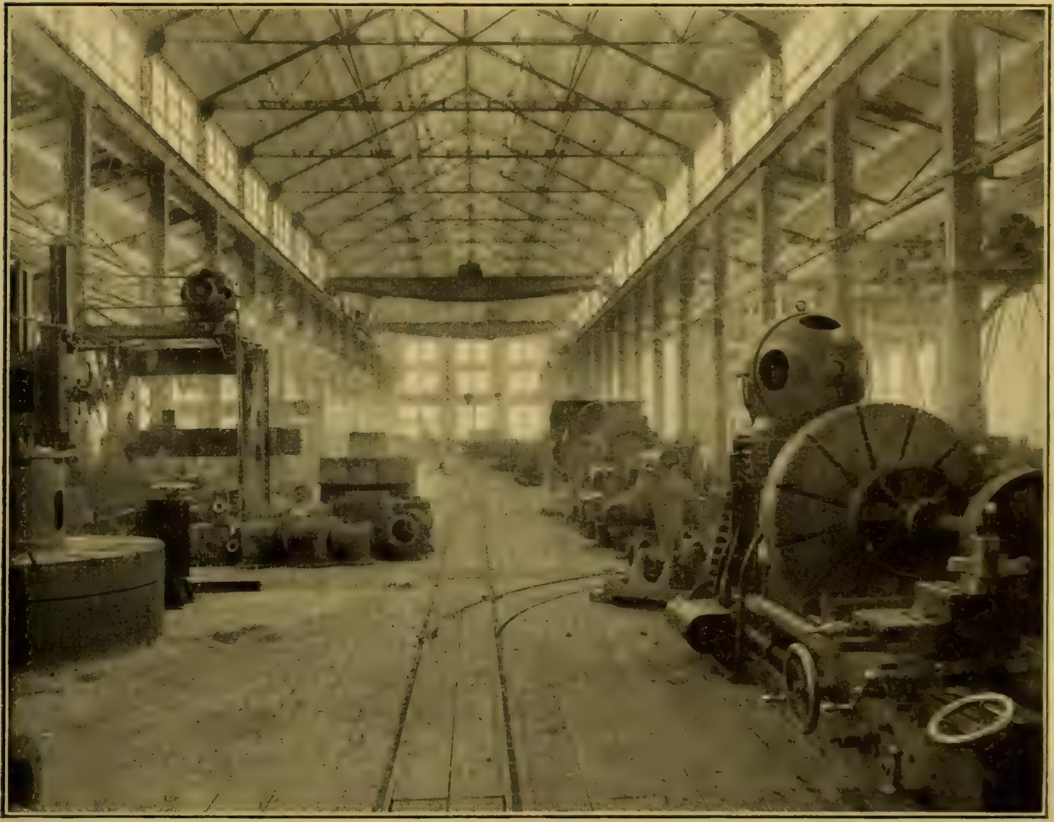


FIG. 12. INTERIOR OF THE NEW SHOPS OF THE JEANESVILLE IRON WORKS CO., HAZLETON, PA.

An example of modern practice in arrangement and equipment.

Figure 15 shows one of the largest machines made by the Norton Grinding Machine Co. It grinds shafts over 22 feet long from end to end to an accuracy of a 0.00025 inch in but a small fraction of the time originally required. Seven thousand pounds can be carried on the centers, while the moving work table, together with its head and foot stocks, weighs 6,000 pounds. The machine is equipped with an emery wheel 24 inches in diameter with 2-inch to 4-inch face, and

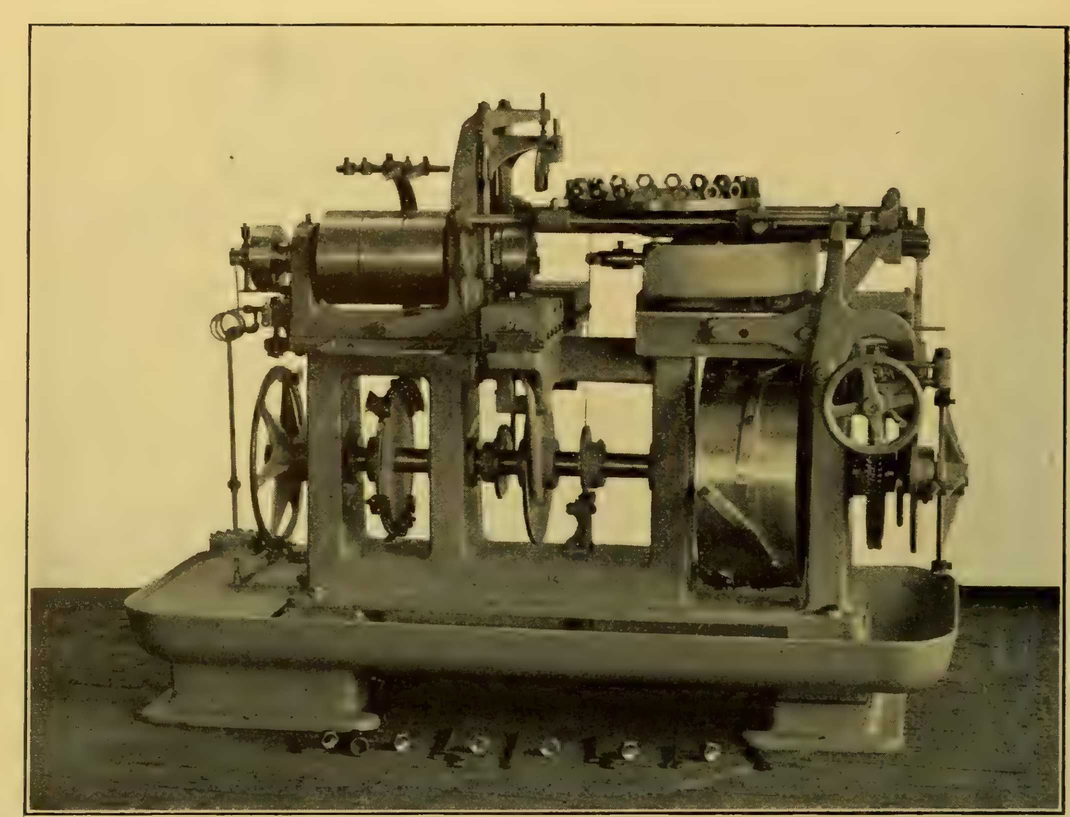


FIG. 13. AUTOMATIC LATHE MANUFACTURED BY THE PRATT & WHITNEY CO., HARTFORD, CONN.

is capable of utilizing 20 horse-power when necessary. On this machine steel work 10 inches in diameter and 10 feet long, rough-turned on the lathe to within 1/32 inch of the finished diameter, was ground and

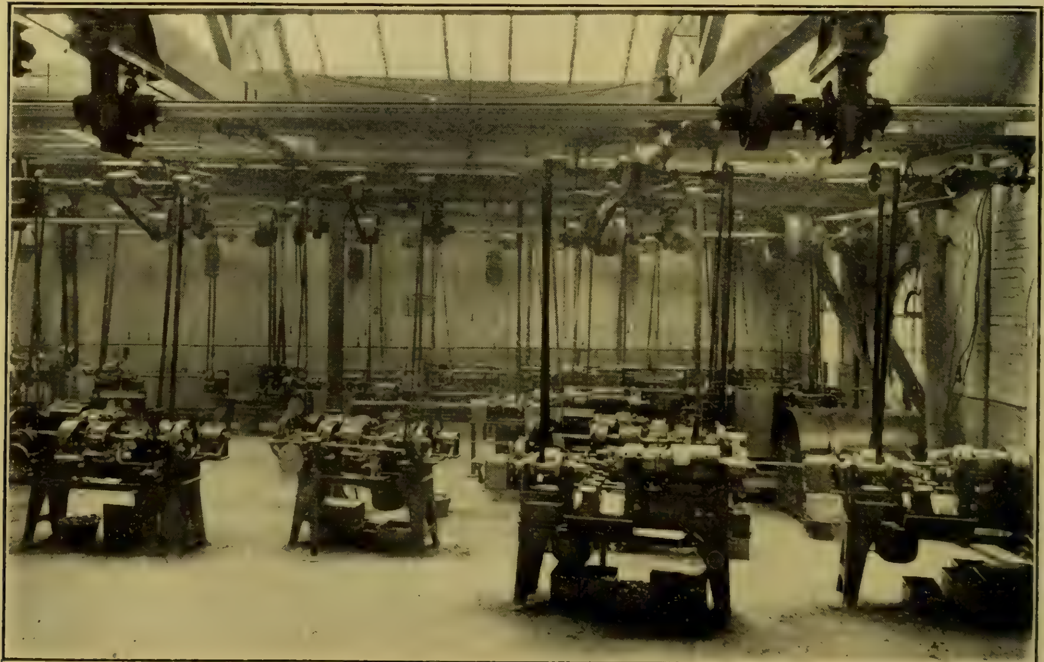


FIG. 14. AUTOMATIC MACHINE-TOOL DEPARTMENT IN THE SHOPS OF MARSHALL, SONS & CO., GAINSBOROUGH, ENGLAND.

finished to the required accuracy in 1 1/2 hours. It would probably require 12 hours to have completed this work in an engine lathe with a file and finishing tool.

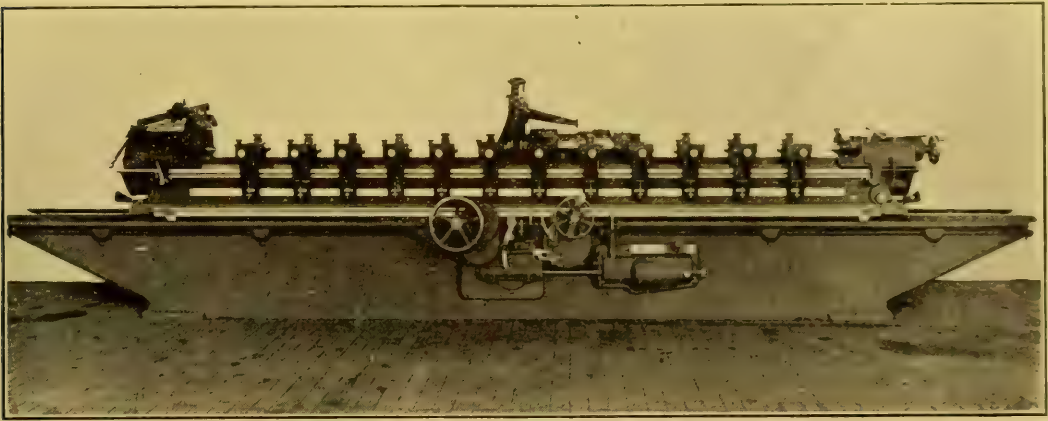


FIG. 15. VERY HEAVY GRINDING MACHINE, BY THE NORTON GRINDING CO., WORCESTER, MASS.

It is now well understood that accuracy and low labor cost may go hand in hand—in other words, interchangeability (one of the most important ends to attain when manufacturing a given line of product in large quantities) should be accompanied with a minimum expenditure of time. The reason for this is clear enough, as accuracy can be attained only by machine work, and machine work is invariably cheaper than hand labor. Think of the cost and the skilled labor that would be required to manufacture a single Colt revolver, and yet, by machinery, these beautiful weapons are made in enormous quantities and assembled without the touch of a file.

We need just as skilled mechanics today as it is possible to obtain, and can afford to pay them high wages, for upon their work largely depends the degree of accuracy attainable. After they have designed and made the necessary dies, jigs, templates, etc., the actual work of manufacture can be carried on by low-priced men. This is the fundamental principle of the modern manufacturing plant. But to keep in the foremost rank it is necessary to use only the most efficient types of apparatus. Competition has become so keen that an improvement in but a detail of a machine may make it impossible for the manufacturer possessing the older type to successfully compete.

There are two articles that will always stand out clearly in my memory: one by Horace Lucian Arnold—"Production to the Power Limit,"* and the other by H. F. J. Porter—"The Radical Policy of Scrapping Costly Machinery."† In Mr. Arnold's paper exception is taken to the old policy of nursing machine tools for fear that they

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* THE ENGINEERING MAGAZINE, August, 1895.

† THE ENGINEERING MAGAZINE, January, 1901.

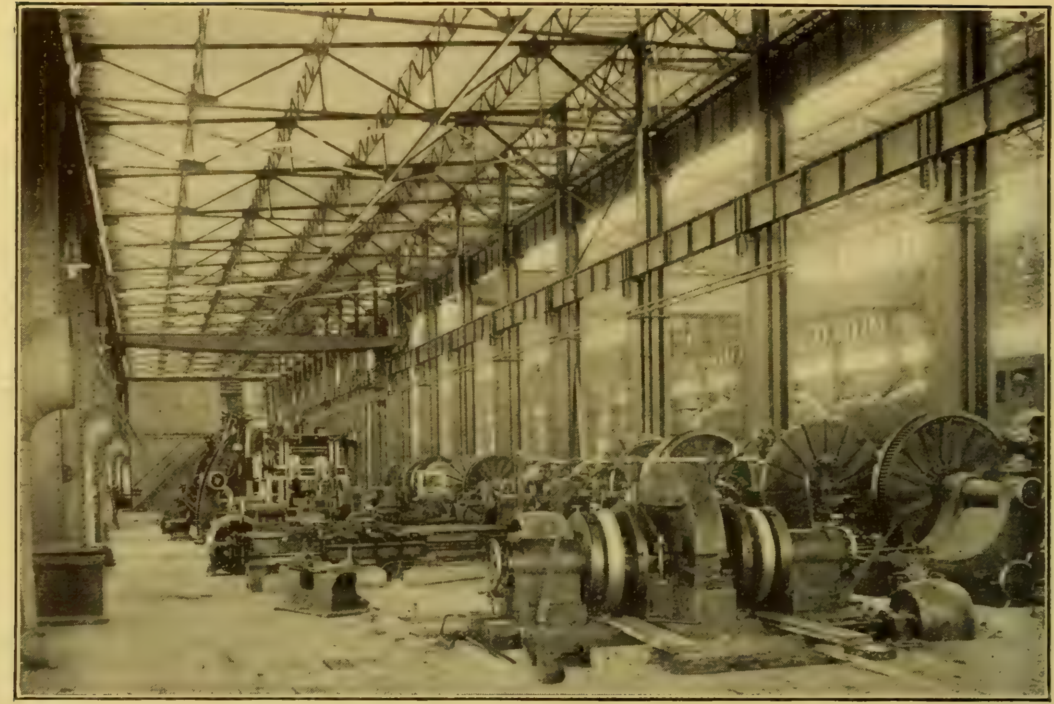


FIG. 16. NEW SHOP OF THE C. R. I. & P. R. R., MOLINE, ILL., SHOWING DRIVING-WHEEL AND CAR-WHEEL LATHES BY THE NILES-BEMENT-POND CO.

may be strained or overworked in any way. He clearly shows its fallacy. The principal item in the cost of production is labor. The time required to do a job is the gauge as to its cost, so that we can well afford to drive every tool to its full capacity, even though such a policy results in a larger repair account. But in the past few years, through investigation and research made possible by our better understanding of such matters, much better results can be obtained through the intelligent direction of machine work rather than merely the driving of a tool by one who wishes to attain its full output but has no knowledge as to what this may be. *The intelligent direction of work characterizes the modern and progressive shop.* Just as the drafting room sprang into existence but a few years ago, so we now find in the most progressive plants a planning department to lay out and direct the shop work in all its details.

While I do not mean to enter into the details of management, I feel that we can never dwell too forcibly upon the importance of such knowledge to those in any way connected with machine-shop work. The tool steel and the machine equipment are of value only in so far as they lend themselves to the accomplishment of economical results in the hands of our workmen, foremen, and superintendents.

The machine-shop problem is an involved one, and to grasp it so fully as to direct all its details with equal intelligence requires the undivided attention of able men in charge of such work.

THE GRINDING MACHINE AS A METAL-CUTTING TOOL.

By C. H. Norton.

Mr. Norton has made cylindrical grinding his study for some eighteen years. His article will do much to dispel the mistaken conception of grinding which has been widely prevalent, and to put the grinding machine in its proper place as a commercial tool in the mechanical world, destined to play an important part in the world's progress in labor saving and labor elevation.—THE EDITORS.

CYLINDRICAL grinding has come to us in the mechanical world by gradual steps, the first step of it, no doubt, being that of a polishing operation; in fact, there are people today whose idea of cylindrical grinding is simply that of producing a polished surface upon the work. There are others who have a little different idea, and yet who still suppose that cylindrical grinding means simply the producing of a perfectly round and straight cylinder with a finished surface to exact diameters, and that because of the possibility of removing *infinitely small amounts of steel* with a grinding wheel, grinding excels only in producing *exact* work. Another thought in regard to grinding is that it is useful only where surfaces are hardened. Still another idea is that grinding may be used only where very delicate work is to be produced.

Within the last six years, developments in grinding have been so great along new lines and methods that today mechanics understand that cylindrical grinding means not only the production of accurate work, but the production also of all cylindrical work in a shorter time than is possible when finishing it to size by the lathe method. Within the last four years machines have been regularly manufactured and sold that remove commercially, when working to their maximum, one cubic inch of steel per minute from cylindrical work. It is easy to understand by the aid of pencil and paper that with this capacity for removing stock, the grinding machine can size cylindrical work to exact diameters much more cheaply than the lathe, when comparatively small amounts of material are to be removed, as represented by cylindrical work that has been roughed in the lathe leaving from 1/64 to 1/32 of an inch diameter. As nearly all cylindrical work can be turned very cheaply to this limit, it is clear that with grinding machines of such capacity, the sizing or finishing cut can be produced much more quickly than by turning in the lathe, provided the finishing cut of the lathe is of a nature that will allow of filing and finishing.

Some idea of the reason for these possibilities with grinding cylindrical work may be understood when we learn that with many modern grinding machines there are from fifteen to twenty millions of cutting points per minute on the work. This becomes still clearer when we learn, as we have within the last two or three years, that the cutting points of a modern grinding wheel are of such shape and quality that the chips removed by them are curly chips, and while they are irregular in form, they show a cutting action similar to that of a steel pointed tool when turning or milling work.

The difference in capacity between the old-line grinding machine and the modern grinding machine, for removing stock, is shown by reference to the cuts made from micro-photographs; these photographs magnify a little more than twenty diameters.

Number 1 shows a photograph of chips from soft steel, ground from ordinary machinery steel about 4 inches in diameter, ground wet, or better, with a cooling lubricant. This lubricant was made of water, soda, and oil. The grinding wheel was 2 inches wide and 24 inches in diameter. It is known by the makers as No. 24, grade "L," "Alundum" wheel. The wheel was running at a surface speed of 6,000 feet per minute.

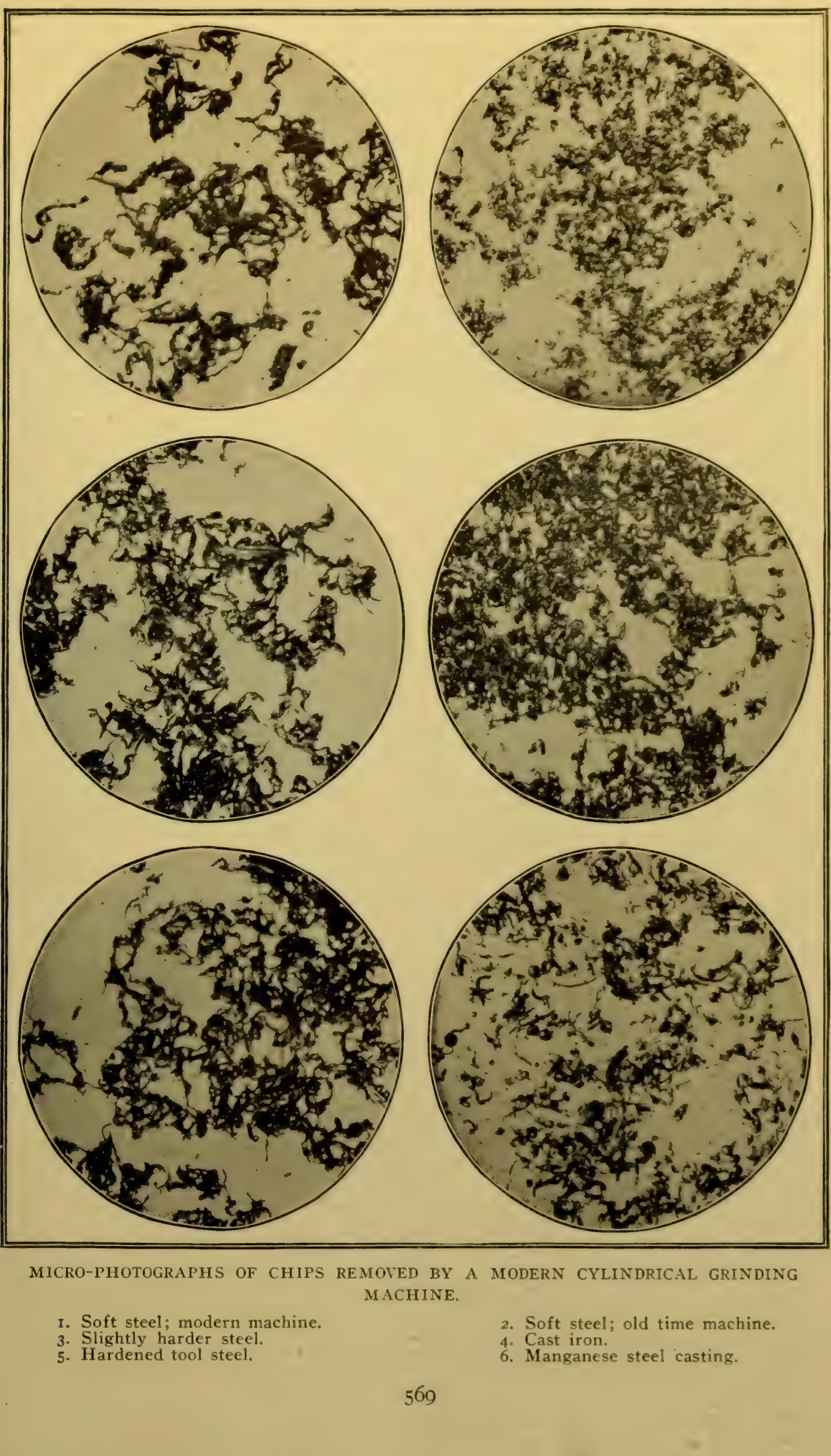
Number 2 shows a photograph of chips ground from the same piece of steel, but by an old-line grinding machine, by the old method. The relative power consumed between the two pieces was approximately about 8 horse power for removing the chips shown in Number 1 photograph and 4 horse power for those shown in Number 2.

In the case of Number 1, there were about nine million cutting points in contact with the work per minute—in the case of Number 2, about seven hundred and twenty thousand.

No. 3 shows a photograph of chips also from soft steel of a little more carbon than the Number 1. Other conditions were the same. It would seem that the greater amount of carbon caused a little difference in the form of the chips with the same treatment.

Number 4 shows a photograph of chips from cast iron. It will be seen that a little more heat develops in grinding cast iron, as there are a very few globules present. These globules are apparently formed by melted particles of iron. There are, however, very few in this specimen, showing excellently clean cutting of the wheel. The wheel used in this case was 2-inch face, with speed of about 6,000 feet per minute cutting surface, and nine million cutting points per minute.

Number 5 is a photograph of chips from hardened tool steel. It is



MICRO-PHOTOGRAPHS OF CHIPS REMOVED BY A MODERN CYLINDRICAL GRINDING MACHINE.

1. Soft steel; modern machine.
2. Soft steel; old time machine.
3. Slightly harder steel.
4. Cast iron.
5. Hardened tool steel.
6. Manganese steel casting.

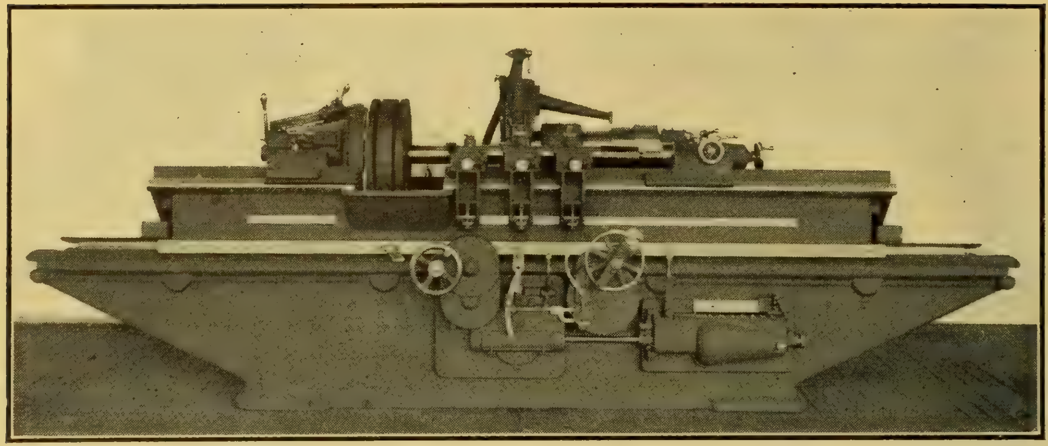


FIG. 7. NORTON GRINDING MACHINE FOR USE IN RAILROAD SHOPS.
Grinding wheel 24 by 4 inches; grinds work 8 ft. long; swings 18 in. diameter.

interesting to note that the chips from hardened steel are also of a curly form. They are, however, finer, because the cutting points of the wheel cannot enter so deeply into the steel. Grinding of hardened steel is consequently somewhat slower than that of soft steel. A No. 24, grade "K" wheel, with 2-inch face and 24-inch diameter, was used for this, with nine mililon cutting points per minute on the work.

Number 6 is a photograph of chips from manganese-steel casting, ground with No. 16 Alundum wheel, grade "N." Manganese casting is, of course, very hard, and the wheel was also relatively hard, an effort being made to use a durable wheel on such rough work. An examination of this picture with a magnifying glass reveals a large number of globules. It is remarkable, however, that there can be any curly chips in this specimen, when we consider the extremely hard substance and the great amount of heat generated by rapid grinding, with a very hard, durable wheel. The globules are, undoubtedly,

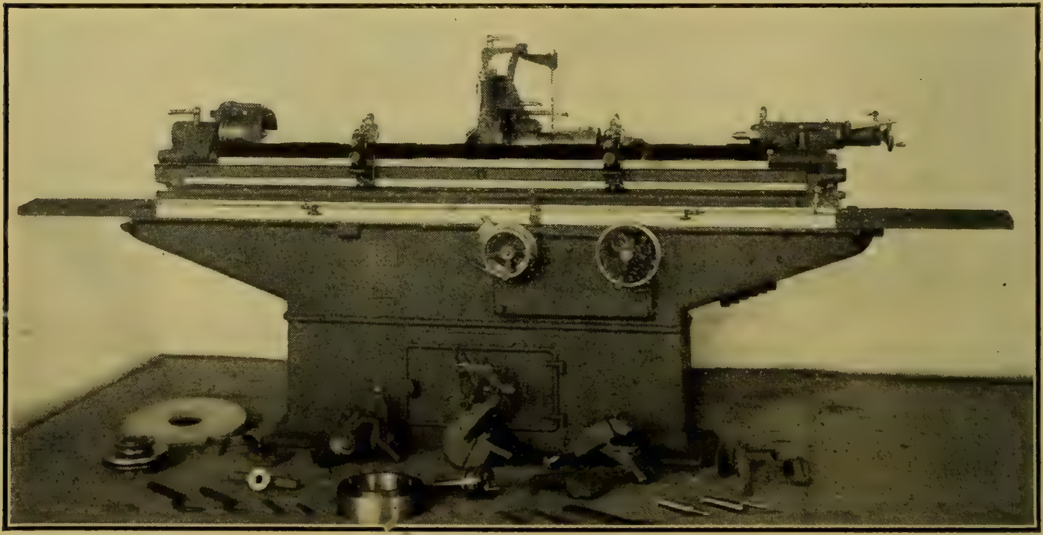


FIG. 8. BROWN & SHARPE 10 BY 72-INCH PLAIN GRINDING MACHINE.

formed from melted particles of the steel overtaken by the flow of water. An interesting feature of these micro-photographs to the grinding expert is this; they show distinctly that the millions of cutting points of the modern grinding wheel act in practically the same way when removing stock as do the familiar steel-cutting tools when turning, milling, or drilling; that is, they really *cut* the steel. Thus, the old conception of grinding, viz., that it is a melting, rubbing, or tearing away of the surface by the grinding wheel, is changed by this revelation of the microscope. Even the worse specimen in this particular—that of the manganese steel, No. 6, shows more than half of the particles to have been cut away, while the remainder may have been cut, but were heated to such an extent as to become melted.

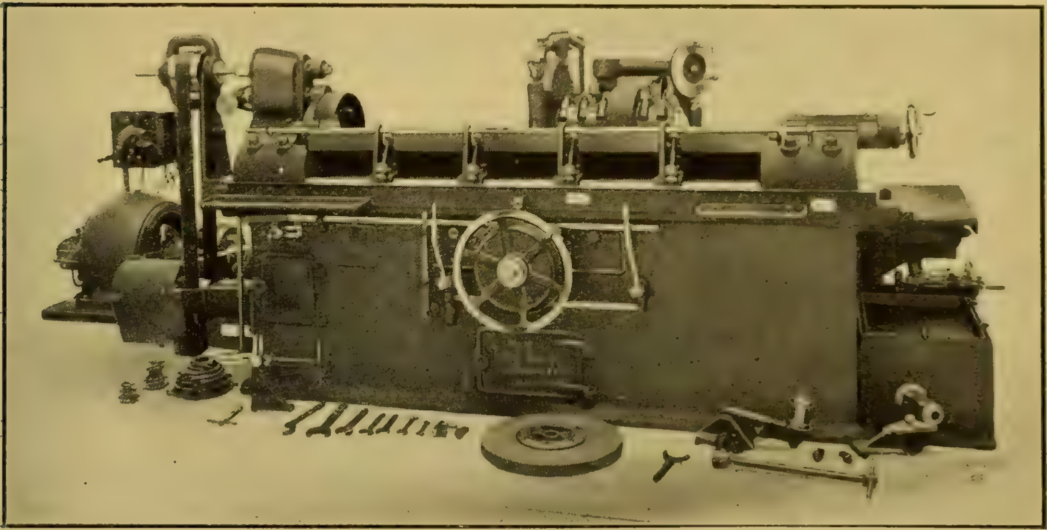


FIG. 9. CYLINDRICAL GRINDING MACHINE, LANDIS TOOL CO., WAYNESBORO, PA.

Figure 10 shows a specimen of work done by a modern grinding machine, and represents a couple of exhaust valves for a Corliss engine. One of them is turned the opposite side towards the observer, and shows the surface left by turning; the other shows the surface left after grinding.

It may be interesting for the reader to know that this particular valve was 26 inches long, 5 1/2 inches diameter; and that it was turned so cheaply in the lathe that the entire time of reducing the diameter 1/4 inch from the casting was only 10 1/2 minutes. It was then ground, reducing the diameter still further, 1/32 inch, in 30 minutes, making the entire time of the cutting tool in the lathe and the cutting wheel in the grinding machine of 40 1/2 minutes, for the production of this ground valve from the rough casting.

Figure 11 shows a lot of plungers for hydraulic cotton presses. They were about 10 inches diameter and 6 feet long. They were ground, complete, removing about 1/32 from the diameter to a thou-

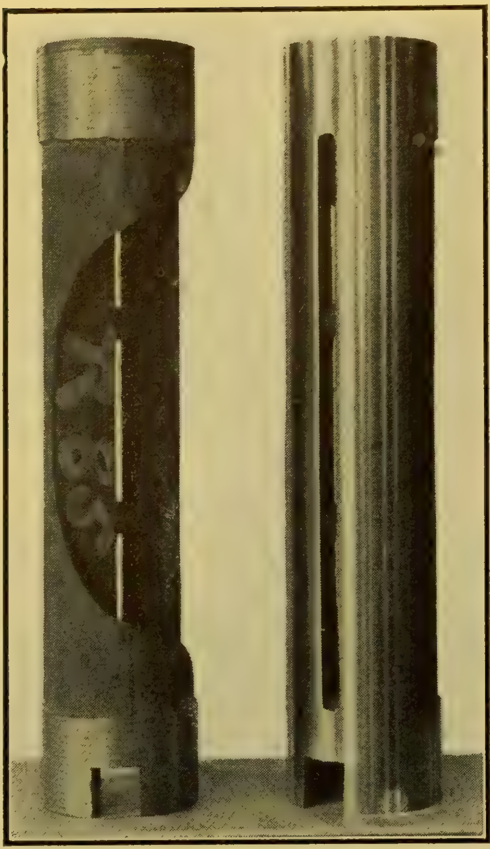


FIG. 10. CORLISS ENGINE VALVES—AN EXAMPLE OF GRINDING.

sandth inch limit for variation of diameter between different ones, and straight, to one-quarter of a thousandth limit of diameter between the two ends. The time consumed in doing this was one hour and a half each. It is quite easy to understand that a lathe operation would require several hours for producing this accurate diameter and finish, after the rough turning was done.

Some idea of the ease with which difficult cylindrical work can be produced may be had by a study of Figure 12 which shows crucible-steel bars 7 feet long, the largest of which is 3 inches diameter, the smallest in the picture being 3/4-inch diameter, and the middle one 7/8-inch diameter. These smaller bars were ground upon centers without turning in the lathe, from the rough black bar, removing 1/16-inch from the diameter. The limit for accuracy was 0.001 an inch in the entire length, and round within a very small fraction. The time consumed in grinding the small bars was three hours each. The large bar was first turned, leaving 1/32-inch to be removed; that also was ground in three hours. An attempt to finish to this degree of accuracy such small pieces in the lathe would either result in failure, or require many times three hours.

The writer witnessed the grinding of some shafts that were 8 inches in diameter and 8 feet long, made of machine steel about 40 points carbon. They were ground, removing 1/32 of an inch from the diameter, complete in two hours each, accurate to gauge, and perfectly round, with a nice finish.

Numerous instances could be cited to show that the modern cylindrical grinding machine is really a metal-cutting tool. As at present designed, it is capable of removing a sufficient amount of metal per minute to enable it to compete successfully with the engine lathe for producing diameters, as well as finish, after roughing cuts in the lathe have been made. There are also instances like the long, slim bars

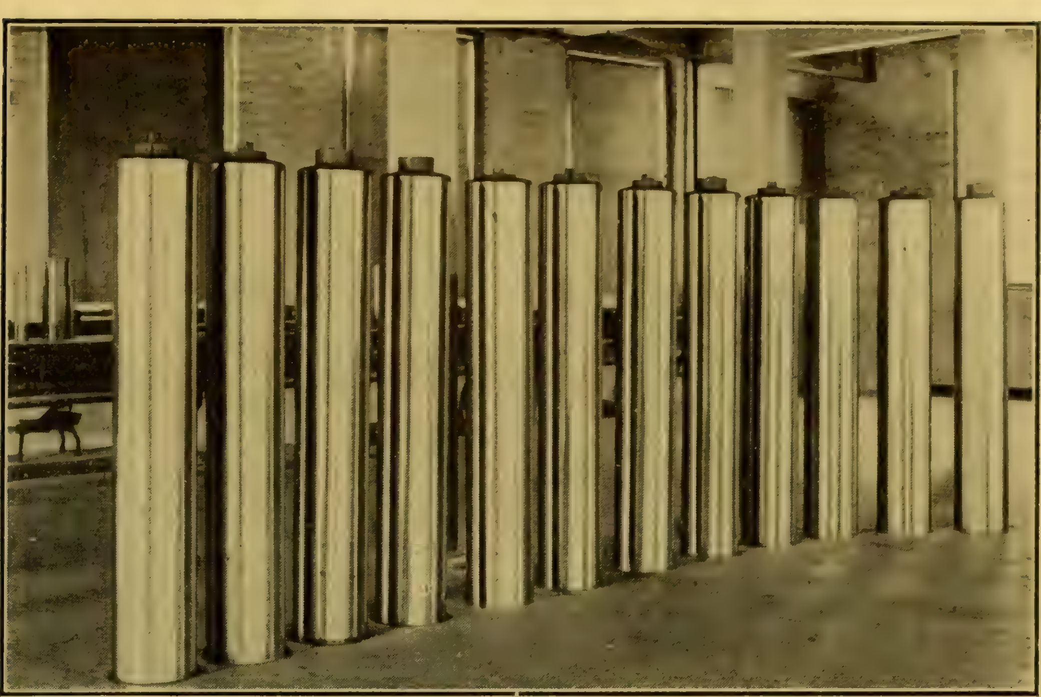


FIG. II. PLUNGERS FOR HYDRAULIC COTTON PRESSES, FINISHED ON THE GRINDING MACHINE.

shown, where a grinding machine does away with the lathe entirely with a great saving of time, the work being very slim and difficult to turn. In the case of locomotive work, piston rods that have been in long service are removed from the engine with the heads intact and are reduced in diameter sufficient for the next size packing rings, ground and finished directly in the grinding machine, without returning, at a great saving of time over the lathe method. In some cases, the rods being bent and badly worn, as much as 1/32-inch radius is removed by this grinding. The time consumed for regrinding and repairing a rod by this method varies from 15 to 25 minutes, complete, from the floor, into the machine and out, the time depending very much on the condition of the rod when taken from the engine.

The grinding machine today has taken its place as a practical metal-cutting tool to be used by progressive manufacturers as a labor saver, and manufacturers to whose attention its possibilities have been

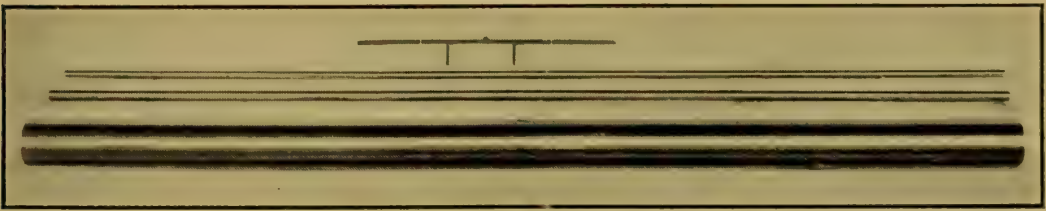


FIG. 12. DIFFICULT CYLINDRICAL WORK PRODUCED IN THE GRINDING MACHINE. CRUCIBLE STEEL BARS, 3 INCHES, ⅞-INCH, AND ¾-INCH IN DIAMETER.

brought, by practical demonstrations, have accepted it as a settled method of sizing cylindrical work, as well as finishing.

As a labor-saving tool, it has been, and to a large extent, it is yet unpopular with labor organizations. This feeling, however, will soon be reversed, in my opinion, for the reason that workmen are learning that by the use of the grinding machine they can make themselves very much more valuable, and thereby gain a larger income.

It is very gratifying to the thinking workman to know that he can so easily, by little experience with the grinding machine, produce such beautiful work in so short a time, and where operators have passed the first stage of their experience with the machines they become intensely interested in them and their work, so that it is probable that ere long the cylindrical grinding machine will be a fixed factor in the production of all round work in the mechanical arts, and that pride in its operation by workmen will be greater than is now shown by operators of the lathe and the planer.

The grinding machine, requiring as it does more thought, greater caution and intelligence in its operation than the lathe or planer, I believe tends to elevate the position of the workmen rather than to degrade it. This view is being taken by many workmen today, who a few years ago were opposed to it.

There is great need of thinking young men who may not have the knowledge of a machine trade, but who have natural tact, care, and refinement in their methods, to become experts in the manipulation of modern cylindrical grinding machines. The field is wide and the demand for such men is, at this time, increasing. When young men shall take the grinding machine seriously and treat it as a friend, with the respect which is due it, and employers shall find they are in earnest and skilled in their manipulation of it, its possibilities for labor saving are so great that the earning power of young men, in connection with the grinding machine, will be larger (in my opinion) than is possible with any other machine tool now known.

The thinking mechanic has a feeling of great satisfaction when he produces commercially what is known as really fine work. As the grinding machine becomes known and used by such men, there must be an enlarged feeling of satisfaction that they can contribute to the world's progress such quality of work at such a minimum cost, and as our workmen become better acquainted with the real laws of progress and of growth in the mechanical world, and as our difficulties between labor and capital become better adjusted, the grinding machine will take a more important place than have any of the machine tools which have preceded it.

DIMENSION LIMITS AND LIMIT GAUGES; THEIR PRACTICAL USES AND RESULTS.

By Arthur A. Fuller.

The phase of practice reviewed by Mr. Fuller lies at the very foundation of the system of standardization and interchangeability, which is in its turn the basis of modern cheap production. It is one of the central principles of up-to-date manufacturing.—The Editors.

THE use of limit gauges for standardizing the products of the machine shop is particularly advantageous for shops manufacturing a standard line of machines, but is also clearly applicable to certain parts of machine work in smaller shops making a wide range of product in small quantities; for in all machine construction there are certain operations performed by standard machine tools, which produce parts having similar geometrical shapes, such as cylindrical or plane surfaces, and these surfaces must be made with an accuracy suitable to the purpose of the mechanism under construction.

There are two methods in vogue for the attainment of this necessary accuracy. The first, still employed in some very large establishments, consist of placing a certain dimension on the drawing, and of having in the shop a single gauge to represent this dimension. This gauge sometimes corresponds exactly to the figure on the drawing, but often is a modification of this figure to allow the piece to properly fit its neighbor. In this latter case, the gauge is usually stamped first with its size in inches and decimals thereof, and second with the special use for which it is intended. The workman attempts to work to this gauge, and an inspector decides whether or not he has successfully accomplished his task. Many factories use this method only for parts or places requiring accurate fitting, leaving the balance of the dimensions called for by the drawing to be produced by the use of boxwood rules or steel scales. We may call this the "single-dimension method." The second method consists of placing on the shop drawings for a required size, two distinct dimensions, one maximum and one minimum, and of having in the shop either two positive gauges, called limit gauges, representing the two given dimensions, or an adjustable measuring instrument capable of being quickly adjusted to the two required sizes. When the workman has brought his work to a size between the two sizes called for, his task is accomplished. This method, if carried to an extreme, would require two dimensions for every size specified on the drawings; few shops, however, do this, but many use the method for certain parts of their work, where experience or past troubles have driven them to it. Other shops do not specify these dimension limits on their drawings, but have standard shop limit gauges which are to be used for all shop work of a given kind. The use of two dimensions, or maximum and minimum gauges, we may call the "dimension-limit method."

Much excellent work is produced by the single-dimension method, and if you ask the shop management how closely the work has to conform to the gauge, you will, almost without exception, receive the reply that it has to be "exactly" the size of the gauge; but upon closer questioning, a most alarming variation in the definition of this word "exact" will be divulged. For some cases, the piece might vary 0.01 inch from the gauge, and still answer every purpose of construction, and satisfy the inspector; in other cases, 0.001 inch variation might not answer for constructive purpose, nor satisfy the inspector, and even if the workman has been given verbal instructions as to the degree of accuracy required, he is never quite sure whether or not he has reached the requirement. It has been said by one of the most expert shop managers of the United States that "it is not work, but worry which wears most on the workman." Is it fair, then, to place upon the workman so uncertain a task? Is it fair to leave the acceptance, or rejection, of his work to another man's touch, which may be more or less delicate than his own? Is it good shop management to allow a man to spend time in attempting to fit a piece accurately to a single gauge, when anywhere within a half a thousandth, or even two thousandths of an inch, will answer every purpose?

But perhaps, you say, even plus or minus half a thousandth cannot be allowed; granted; but some limit must be allowable, for neither tools nor workman can produce absolute perfection. Whatever then is allowable can be specified, either by dimension limits or limit gauges. The best draughting rooms show the most attention to detail, and specify most explicitly the requirements for the finished product. It is simply impossible to modify a dimension by an adjective expression which will mean the same to every engineer, foreman, workman, or inspector connected with the work. It is, therefore, evident that if definiteness of instruction, uniformity of product, and contentment of the workman are desired, something different from the single-dimension method is required. Experience is proving that the dimension-limit method removes, in a simple and direct way, the disadvantages of the old system. Its most satisfactory application consists of placing dimension limits on the drawings for some classes of work, and of having shop limit gauges for other classes of work.

Under the latter class, the cylindrical hole falls most naturally, as the expression "standard hole" is perhaps more frequently heard than any other in the machine shop. Nevertheless, only a small portion of the holes made in a shop are ever gauged in any way to determine their size. Rough-drilled holes often answer every purpose; reamed holes varying from plus or minus 0.002 inch will answer many purposes; while for other good commercial work, only plus or minus 0.00025 inch can be allowed. For a drilled hole, the word "drill" is usually thought to be sufficiently definite to specify on the drawing, and for finer work the word "ream" is commonly employed. Such specification will answer for a large class of cases, as drills sharpened on a drill grinder, and used with ordinary care, will produce a hole within 0.01 inch or 0.02 inch of its own size; but even so, a shop inspecting its own work could use, to advantage, a set of rough-limit plug gauges in insure, first, that the correct size of drill has been used, and second, that the drill used is producing holes within say 0.02 inch of its intended size.

For reamed holes, the necessity for limit gauges is absolute. Where the work is uniform, one set of gauges may answer for a shop standard, the limit allowed conforming to the character of the work. If only one set of limits is used, the word "ream" on the drawing is sufficient, but if different degrees of accuracy are desired, some sign will be nesessary to designate which set of gauges is to be used, say set A or B. One noted New England shop uses a limit from standard to minus 0.001 inch for all ordinary holes, and a single-standard plug gauge for finer work. Another shop uses, for holes below 1¼ inch, a limit of plus or minus 0.00025 inch; for holes between 1¼ inch and 2½ inches, plus 0.00075 inch and minus 0.00025 inch; for holes over 2½ inches, plus or minus 0.001 inch. Perhaps these various hole limits illustrate better than anything else how well the dimension-limit system adapts itself to any degree of accuracy required. With the modern methods of grinding and lapping, several of the best tool shops of the United States could furnish limit plug gauges varying plus 0.0001 inch, and minus 0.0001 inch from standard, which, of course, would mean a very high grade of commercial work for reamed holes; but even such a set of gauges would be more satisfactory to work with, than one gauge with the requirement that the hole must be "exact" size of the gauge.

Having established limits suitable for holes, the next problem is to establish limits for cylinders designed to be some special fit, such as a force, drive, or running fit, in these holes. I was formerly of the opinion that limit wires, or rods, for each of these fits, and for all diameters in common use, should be made and handed out to the workman with his drawing or other instructions for the work; but the development of the micrometer caliper into larger sizes at a moderate cost has altered the conditions, so that today a more flexible and less expensive system is obtained by the purchase of these instruments in sufficient quantity to satisfy the requirements of the shop. These allow a wider range of fits for any given size of hole, for it is found, in some cases, that fits depend on the kind and form of material being used. Figure 1 shows an engine shaft with the limits allowed for the various fits specified thereon. The portions marked 15-15/16 inches and 16 inches "to gauge" are so designated to accommodate the single-gauge system of the armature builder who, in this case, furnishes the engine builder with a single gauge for this portion of the shaft. As a matter of fact, if this portion is turned to within plus or minus 0.001 inch of this gauge, the armature builder would probably not hesitate to force on his armature. This degree of accuracy is readily obtainable on such work, and if a limit of only plus or minus 0.0005 inch were allowed, it would be more satisfactory to work to than the single dimension, although it would require great care.

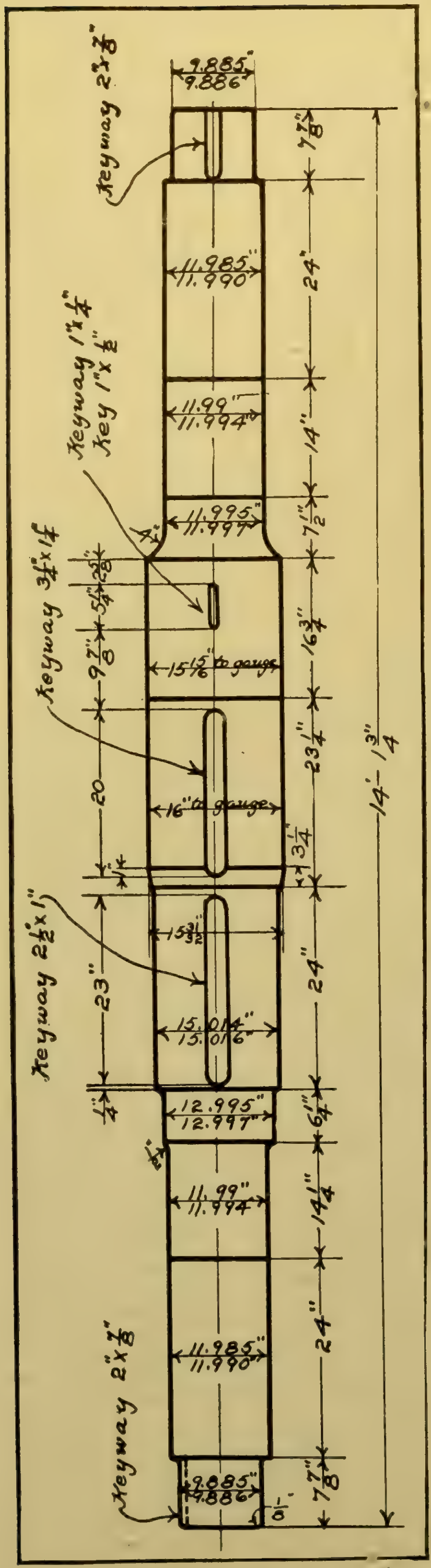


FIG. 1. LIMITS FOR THE VARIOUS FITS ON AN ENGINE SHAFT.

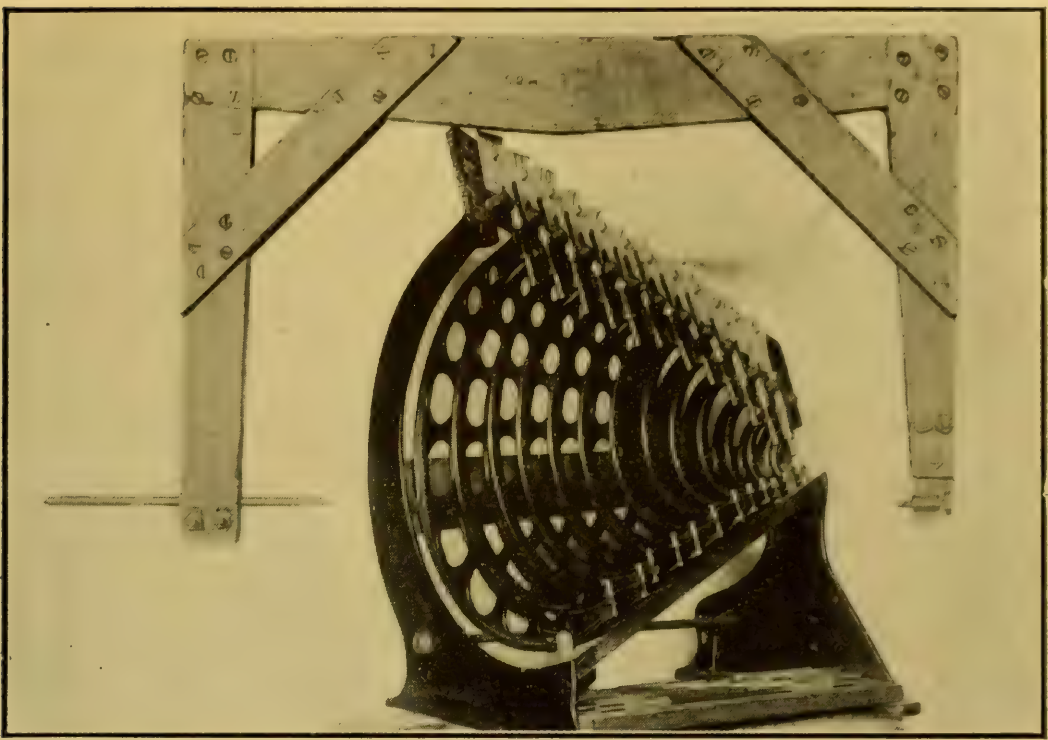


FIG. 2. SET OF SLOCOMB STEEL FRAME MICROMETERS, 0 TO 12 INCHES. ALSO HOME-MADE PINE-FRAME CALIPER WITH MICROMETER POINTS, USED WITH STANDARD RODS TO MEASURE FROM 18 TO 22 INCHES.

Dimension limits are particularly adapted to producing interchangeable work, but may also be employed to produce a desired closeness of fit, independent of the actual size. Thus, Figure 3 shows an assembled vacuum pot for a steam engine. In this case, it is not necessary, or even desirable, for the different parts of these pots to be interchangeable. But it is absolutely necessary for the successful working of the pot that the clearances for the running fits be uniform within very narrow limits. In this case, the exact sizes are not expressed on the detailed drawings, but simply the nominal dimensions, but the table of allowed variations, shown in Figure 4, is given to the workman with the drawing. By a careful study of the table it will be observed that not only is the allowed difference in diameter between the two pieces specified, but also the allowed ellipticity or variation in diameter for each piece, and the sum of the ellipticity for the two pieces. In order to obtain such accuracy, it is necessary to grind the plunger and bottom together by means of ground glass and oil.

Before the application of the dimension-limit system to this work, a very peculiar experience was met with. The pots were made in identically the same manner as at present. The plungers were first bored to diameter, and the bottoms then turned to match, leaving a

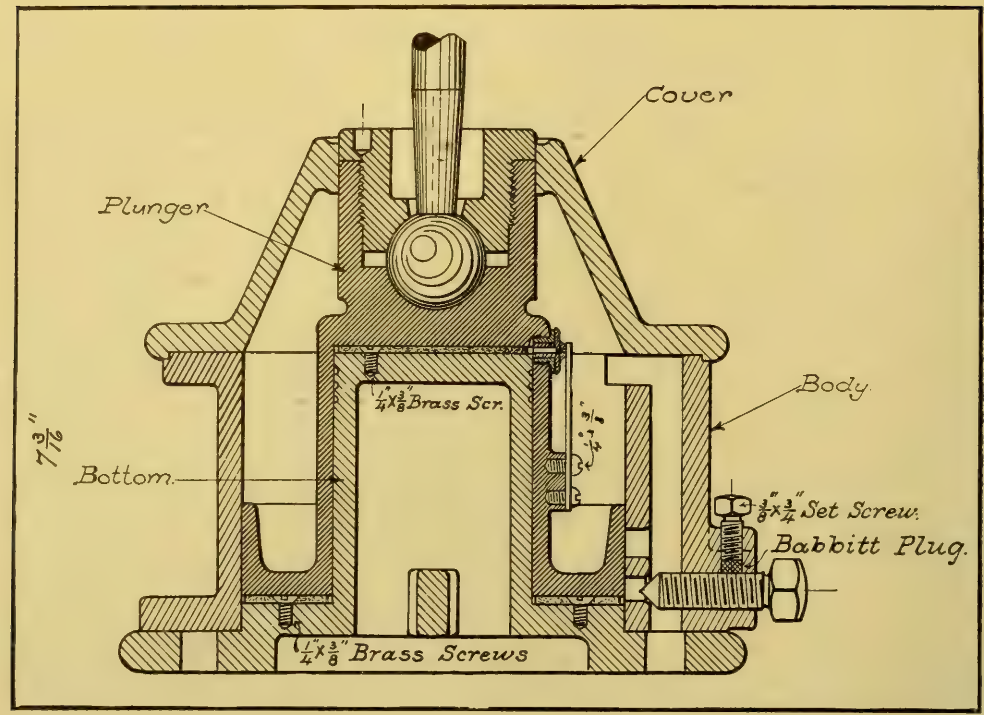
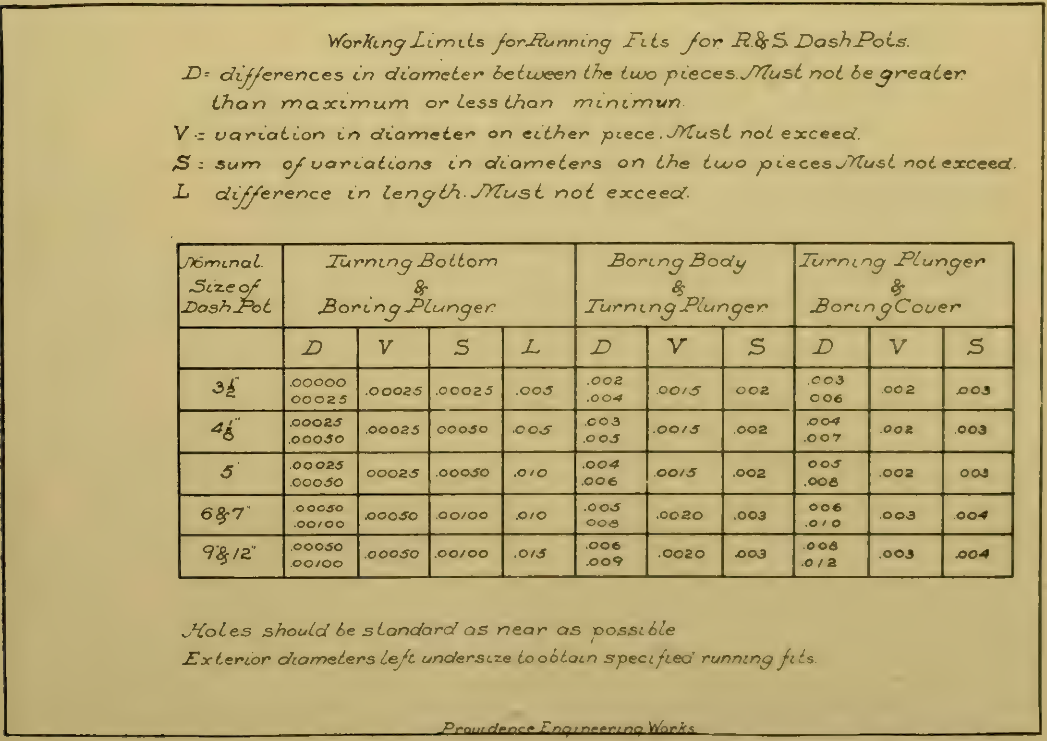


FIG. 3. SECTION OF ASSEMBLED DASH POT FOR A STEAM ENGINE.

few thousandths for grinding. After grinding, the pots were placed in a testing machine, arranged to give them a variable lift, and any desired number of strokes per minute, were run for several hours, and finally landed in the stock room. Erecting men soon began to report the most erratic actions of some of these pots, the most common difficulty being that of sticking or seizing. Upon measuring the diameters of these pieces, it was found that the diameter of the hole in the plunger was smaller than the cylindrical portion of the bottom, by 0.001 inch to 0.0015 inch, for its entire length with the exception of an enlargement, or taper, at the mouth of the hole, extending in about ½ inch. This allowed the bottom to enter the plunger, and, as long as the two pieces were in motion, either when revolving in the lathe during the grinding process, or while stroking up and down under the testing machine, the two pieces would move freely one upon the other—so freely, in fact, that either of these motions could be easily duplicated by hand. If, however, the two pieces were left together for a few minutes, they would seize so tightly, even if thoroughly oiled, that it required several severe blows from a lead hammer to free the parts. Proper precautions were taken to obviate the influence of expansion due to heat, and, of course, when running together the plunger was larger than the bottom, but the small amount of work required to cause the expansion of the plunger and the compression of the bottom sufficient to allow them to run, was simply paradoxical. However, the seizing was a decided defect that entirely disappeared under the dimension-limit method.

A more difficult field for dimension limits is found in the fit between a thread and its nut when both are made several diameters long. Here the pitch is essential as well as the diameter. Threaded holes are made standard by using expansible taps, or by threading with a tool in the lathe until a minimum threaded sizer will enter. For the exterior thread the pitch is easily determined by testing the travel of the carriage of the lathe, by means of a vernier allowing only a specified variation, and the diameter by means of a "V" thread micrometer. As the latter are regularly manufactured only in small sizes, a "V" thread comparator in connection with any threaded sizer representing the shop standard is a practical and inexpensive instrument for gauging threads. This instrument is "C" shaped similar to the "V" micrometer point at the other, but does not give any absolute readings in inches. It is given to the workman with the threaded sizer from the tool room. The workman first calipers this sizer, with the comparator, obtaining an arbitrary reading; he then threads his pieces within specified limits of this reading, say 0.003 inch to 0.005 inch under, for a given diameter, to allow his work to screw with the proper looseness into the threaded hole.

Although diameter limits are important, simple length limits are often time-savers. It is also true that dimension limits applied to the



Working Limits for Running Fits for R.&S. Dash Pots.

D= differences in diameter between the two pieces. Must not be greater than maximum or less than minimun.

V = variation in diameter on either piece. Must not exceed.

S = sum of variations in diameters on the two pieces Must not exceed.

L difference in length. Must not exceed.

Nominal. Size of Dash Pot	Turning Bottom & Boring Plunger.				Boring Body & Turning Plunger.			Turning Plunger & Boring Cover		
	D	V	S	L	D	V	S	D	V	S
3½"	.00000 00025	.00025	.00025	.005	.002 .004	.0015	002	.003 006	.002	.003
4⅛"	.00025 .00050	.00025	00050	.005	.003 .005	.0015	.002	.004 .007	.002	.003
5"	.00025 .00050	00025	.00050	.010	.004 .006	.0015	.002	005 .008	.002	003
6&7"	.00050 .00100	.00050	.00100	.010	.005 008	.0020	.003	006 .010	.003	.004
9&12"	.00050 .00100	.00050	.00100	.015	.006 .009	.0020	.003	.008 .012	.003	.004

Holes should be standard as near as possible

Exterior diameters left undersize to obtain specified running fits.

Providence Engineering Works

FIG. 4. TABLE OF ALLOWED VARIATIONS IN THE DASH POT SHOWN OPPOSITE.

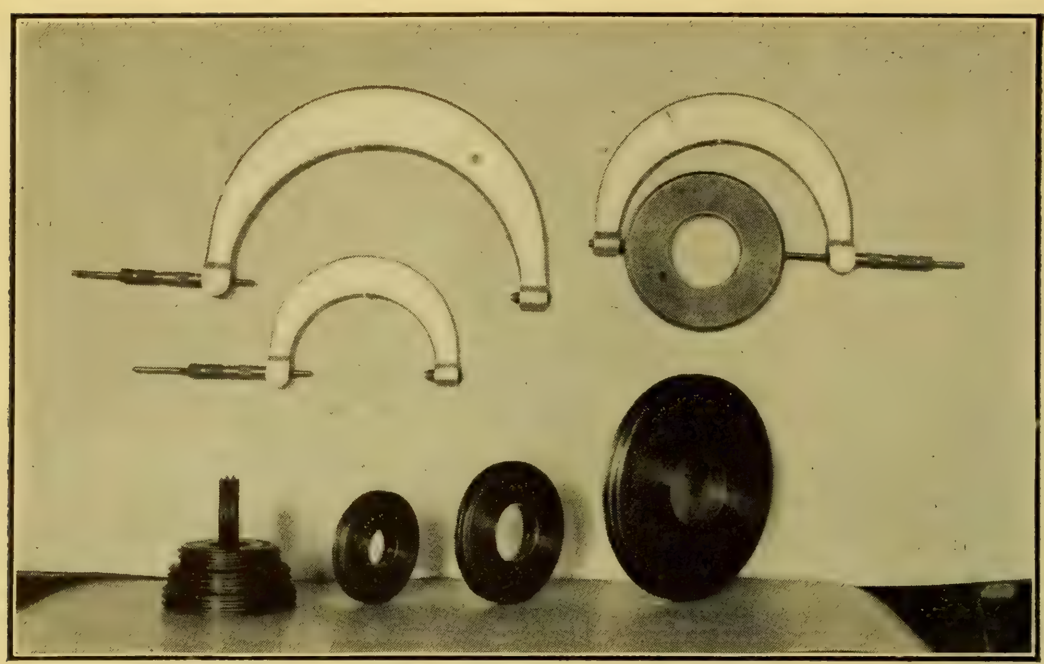


FIG. 5. THREADED DISC SIZERS AND ALUMINIUM-FRAME THREAD COMPARATORS WITH MICROMETER POINTS.

coarser or less particular work of the shop may save a large amount of time and needless expense. For a length, plus or minus 1/4 inch variation is worth specifying, and enables a man to use a tape line or a pole; or a limit of from standard to plus 1/16 inch will enable a man to use his measuring rule with impunity and feel sure of the result; while plus or minus 0.01 inch would lead him to use a steel scale with great care, and plus or minus 0.001 inch would show him that special length gauges or vernier measurements were necessary.

For compound lengths and for pieces of complicated shapes, it is often an interesting problem and one calling for the best of mechanical judgment to prescribe limits which will not add up so rapidly as to be prohibitive as totals, and it is sometimes advisable not to allow the summation of successive maximum and minimum length limits to hold as an overall dimension; a note calling attention to this should be added so that the workman may not be led into difficulties.

In conclusion, the principal labor-saving factor of the dimension-limit system lies in this one fact, that the "good enough" point is defined to the workman in positive measurements or by positive gauges which leave no doubt in his mind as to the degree of accuracy required. The system requires the closest touch between the shop and draughting room, so that only the most practical limits will be specified. For shops employing an uneducated class of labor, or where it is not desirable to send dimensioned drawings into the shop, limit gauges for all dimensions will accomplish the same purpose.

INSPECTION AS A FACTOR IN CHEAP PRODUCTION.

By Charles U. Carpenter.

Inspection is the corollary and complement of standardized manufacturing. Mr. Carpenter's theme is therefore to the works manager what Mr. Fuller's is to the mechanical superintendent of the factory.—The Editors.

"CHEAPER Production" is today the war cry of superintendents, managers, and manufacturers. Strenuous efforts are constantly being put forth and every device is being adopted to accomplish this. Improved automatics of every description, latest types of extra heavy machinery that can be worked to the limit of speed and feed, new high-speed steel cutting tools and small tools of all kinds, are being introduced constantly; improved methods of factory accounting are being seized upon, in order that the manufacturer may determine with certainty what processes should be first attacked; work is being carefully analyzed and specialized; the individual workman is being stimulated to a high rate of production by new systems of pay. Every nerve is strained to reach "cheaper production."

That the result will be reached cannot be disputed. But is the ordinary factory properly organized to care for work produced under such new conditions? Is there provided any method by which the manufacturer can be guaranteed work of as high quality as formerly produced? Or can he feel sure that the saving made at one point of manufacturing is not consumed at another point, through extra time consumed in fitting and adjusting defective parts? We may be sure that, unless proper precautions are adopted, this "rushing of production" is attended with much danger.

I have in mind the product of two large concerns which have been very active in the introduction of up-to-date methods of production and of lowering costs. But the decline in the quality of their product, and the consequent loss of a prestige gained through long years of endeavor, is a striking demonstration of the folly of such methods when these methods are not coupled with a thorough system of overseeing the work, or "inspection."

In still another case large sums are being lost in the erection of heavy jobs because of inaccurate shop work. Such losses are by no means uncommon. The executive officers are usually unaware of the conditions, as every effort is made to conceal errors. As a consequence, loss of prestige or cash comes upon them as a total surprise.

In the midst of this rush one must conclude that the need of inspection, great as it was under old conditions, is intensified by the use of these new means of production. The average manufacturer considers it well-nigh a useless expense to employ men to look over work done by other employees. He will seldom look upon the inspection as a strong factor in the reduction of his costs and will often refuse to permit of the expenditure of the sum necessary to secure it. This is a great mistake. He may be sure that the tendency toward specialization of work and intensifying of output will render some comprehensive system of inspection absolutely necessary. Workmen will generally do no better work than they are required to do. With foreman and superintendent constantly after them, with records before them notifying them of the time in which a job can and should be done, with the bait of increased pay dangling before their eyes, and the feeling that to hold their job they must make the record, it is but natural that they should slight the quality of the work, when they know there is a good chance that such work will not be detected. Under such circumstances the amount saved will usually be lost many times over in the final assembling of the machine. This is especially true when the work of assembling, as well as machining, is highly specialized. In the case of complicated machines especially it is far more economical to specialize the assembling of parts and complete the machine, job by job, than to have one or more men assemble all the parts into the machine. It is evident that the approved plan of specialization makes close inspection all the more necessary.

Results of Inspection.—First, quality. It needs no argument to demonstrate that a rigid system of inspection will improve a bad article or keep up the quality of one already good. The prompt rejection of imperfect parts (for which the workman must pay) soon convinces even the careless one that it is to his interest to produce work of a satisfactory character. An inspector with a first-class backbone will soon instil this into the minds of the men. It is surprising, too, to note how quickly men can reach a high standard of work, and adhere to it, if it be insisted on, and how small will be the loss.

Among many personal experiences I recall a case that was a typical one. It was necessary to drill and ream holes ½ inch in diameter in three lugs, located 3 inches apart, projecting from a small iron casting. These holes had to be reamed within a limit of 0.0005 inch under ½ inch. On the first lot of 400 parts finished, the inspector promptly rejected 398; on the second lot of 350 he rejected 32; but on all lots after that the loss did not exceed one-half of one per cent. In this particular factory the total per cent. of loss on a total of 20,000,000 pieces inspected per year did not at any time exceed *one-fourth of one per cent.* All losses caused by carelessness were charged against the workmen. Undoubtedly the cause of this low per cent. of rejection was the concentration of the workman's attention upon his work. This results from his feeling that he will be paid only for good work and will suffer for his bad work. Excellent results can be secured, especially in small shops, by keeping a record of results of different workmen's output, and thus finding out the efficient and inefficient workmen.

The importance of keeping up the quality of work cannot be overestimated. It is often a comparatively easy matter to hide defects by a liberal application of plaster and paint, so that a job upon shipment may be perfect as far as appearances go, only to cause trouble, incur expense, and damage reputation after it has reached the customer.

Quantity.—The fear that careful inspection will seriously affect the quantity of work turned out per man is unfounded. While it is true that in some cases where extreme carelessness has prevailed some diminution in output can be expected, a mechanic working upon ordinarily close work will turn out practically the same amount of work whether inspected or not, under conditions as at present existing in up-to-date shops, where he is provided with proper tools and gauges, instruction cards, etc. The fact that the concentration of his attention upon the work must be increased by reason of this inspection will result in many cases in an increased output. A wide experience in this work leads me to the belief that under usual conditions the manufacturer cannot afford to do without a careful system of inspection, and that the effect on the product both as regards quantity and quality will be surprisingly favorable.

Elimination of Imperfect Parts.—The elimination of imperfections before work goes to the final assemblers is of great importance. In fact, this is absolutely necessary in order to have rapid, accurate, and cheap assembling. As stated before, modern economical methods generally require that the component parts of a machine be assembled job after job, until the machine itself is finally completed. The economy of this method over the old one of having the entire machine assembled by one man cannot be doubted. But, as can readily be seen, these parts must be accurately machined, and unless inspected there is no assurance, and indeed little likelihood, of such being the case. Generally speaking, the specialization of assembling and the elimination of filing and fitting in the assembling departments, through accurate machine work, will result in very satisfactory economies. A walk through the average assembling department by one who closely observes the assemblers at work, will show the possibilities in the case.

Accurate machining, which can be produced only through careful inspection, will enable the workmen to assemble the parts so much more accurately and quickly that the saving to these departments alone will often pay many times over for the cost of inspection. Again, the product itself will be much more accurately built. The accurate duplications of parts effect not only the ease of assembling, but also the ease of repairs. This in itself is often a very important item. The larger the business, the more important does it become.

Protection.—A proper, even though simple, system will provide needed protection to the company through the fact that the workmen will receive pay only for good work and will be charged with all bad work. This in itself is a valuable economic factor. In many factories the checking up of time tickets is not done systematically or carefully. This leaves a way open for those not honestly disposed to take advantage of the firm. In a well systematized factory the checking up of tickets becomes an important feature of the system. It is also well to arrange wherever possible to have different inspectors examine different operations upon the same lot of stock. In this manner one inspector will check the other.

Authority of the Inspector.—The authority of the inspector and his decisions should be unquestioned. Weakness on his part will be noted immediately by the men and advantage taken of it. If they conclude that by appealing to a higher authority his decisions can be reversed they will soon make his lot a warm one. I have known instances where the men purposely lowered the quality of their work little by little, in order to discover the limit that the inspector would allow. Good men are needed for inspectors, as the qualifications necessary to make a success of such a position are many and peculiar. A well organized inspection force, even though small, often provides a good training ground for bright men. Indeed, the success of a product often depends upon careful inspection. The more complicated the product the greater the need.

In some factories a separate inspection department is provided, and all work is brought to this department to be inspected. This need not be done on every operation but should be done on all those requiring close examination. When this is possible the advantages are numerous. The work will thus always be under the eye of the head inspector, and the inspectors themselves will not be subject to any improper influence on the part of the workmen to slight their work. This factor of "influence" is not to be neglected. In one factory when very close work was necessary it was found impossible to secure proper results until the inspectors had been taken away from the machine rooms. It was also found that the extra expense of hauling the work to the inspection department was more than made up by the time gained by the inspectors themselves in their own work. Again, the many valuable gauges were thus kept under the control of the head inspector instead of being scattered through the shop. This is often important, not only because of their value, but also because they can thus be examined frequently for accuracy.

In many cases, however, owing to the nature of the work, it is impossible to form such a department. The inspectors must go to the work. In such cases an inspector's report is necessary. Such a report can be so devised as to provide a check upon the inspector both for accuracy of work and time consumed by him in inspecting. Much time can be wasted in this work unless proper checks are kept upon it. Care must be used in such cases to see that the inspector properly accounts for all gauges used by him.

In some factories one workman is used to inspect the work done by the man on the preceding job. On work of a simple character this plan is fairly effective, but it may well be considered crude when applied to complicated or close work. The time lost by the workman will be many times the amount consumed by an expert inspector. Again, in many cases where men are working side-by-side the one will not report his mate, but will either attempt to use work that should be rejected or will turn it back without any report. In this way an error may exist in work and not be discovered until too late. In any event the firm loses this time and also the opportunity of discovering its good and its bad workmen—a most important feature.

It is of course obvious that a thorough final inspection should be given all articles. It is important to note the necessity of giving it one inspection before the final finishing of the work. Plaster and paint skilfully distributed are first-class agents in concealing bad work.

Inspection of Scrap.—It is important that proper attention be given to the question of scrap. In the first place, whenever possible the strict rule should be made that no one but the inspectors can consign any stock to the scrap heap. Stock coming from any department should not be be scrapped without a full explanation from the foreman. In many cases it is advisable to hold the scrap stock for the superintendent's attention. Meetings of the foremen, with the scrap before them, can be held with very good results. The reasons for heavy wastes can thus be determined easily and accurately. The foremen should be continually checked up on this, and held subject to severe censure for unreasonable losses. When they realize that explanations and reasons must be forthcoming they very soon give this matter their personal attention. Few firms realize the amount of money lost through lack of attention to this detail.

Examination of Gauges.—Most important is it to have some system whereby all gauges and tools, both in inspectors' and machine departments, shall be inspected regularly and compared with the tool models, to ascertain whether or not they have become worn. The neglect of this seemingly small point has worked more than one firm's undoing. Large losses have accrued in many instances through the machining and assembling of parts that are "correct according to incorrect gauges only." Even with the exercise of care and vigilance it is possible for such defective work to get out of the factory, only to cause large losses afterwards. To overcome this it is only necessary for either the tool maker, or the head inspector, (preferably the former) to keep a card index of all tools and gauges used throughout the factory. By the proper arrangement of cards so that each tool or gauge will be called to his attention for examination in its proper turn, what might be a formidable task becomes easy, and accuracy of these important parts is insured.

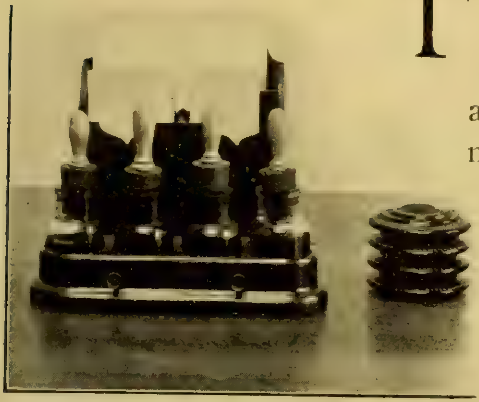
Scope of Inspection.—Inspection in its broadest sense is by no means limited to the work so far discussed. The idea may be profitably extended to more than one branch of business. Among the most important is the inspection of designs and drawings. This is particularly the case in work where standardization is not possible. Many a firm has been driven to the verge of ruin through following blindly the designs of a fanciful theorist, who designs the work without regard to either the economy or the practicability of its production. The closest possible touch between factory and designing department is absolutely necessary. The designing department should not be permitted to send new designs into the shop until these have been inspected by the shop foremen. A meeting between the two divisions should be arranged to provide for a discussion of the most economical methods of designing work and of producing it. In other words, not only should the work of the foremen be inspected, but also the work of the designing room should be most carefully checked up, errors corrected, and means discussed for cheapening the production.

Every manufacturer should pause in the midst of the rush and ask himself if the quality of his product is safeguarded by a proper and efficient inspection system. The need of such work is greatly increased by reason of the greater speed of production which is being attained by reason of new tools and new processes.

THE DRAFTING DEPARTMENT AS A FACTOR IN ECONOMICAL SHOP MANAGEMENT.

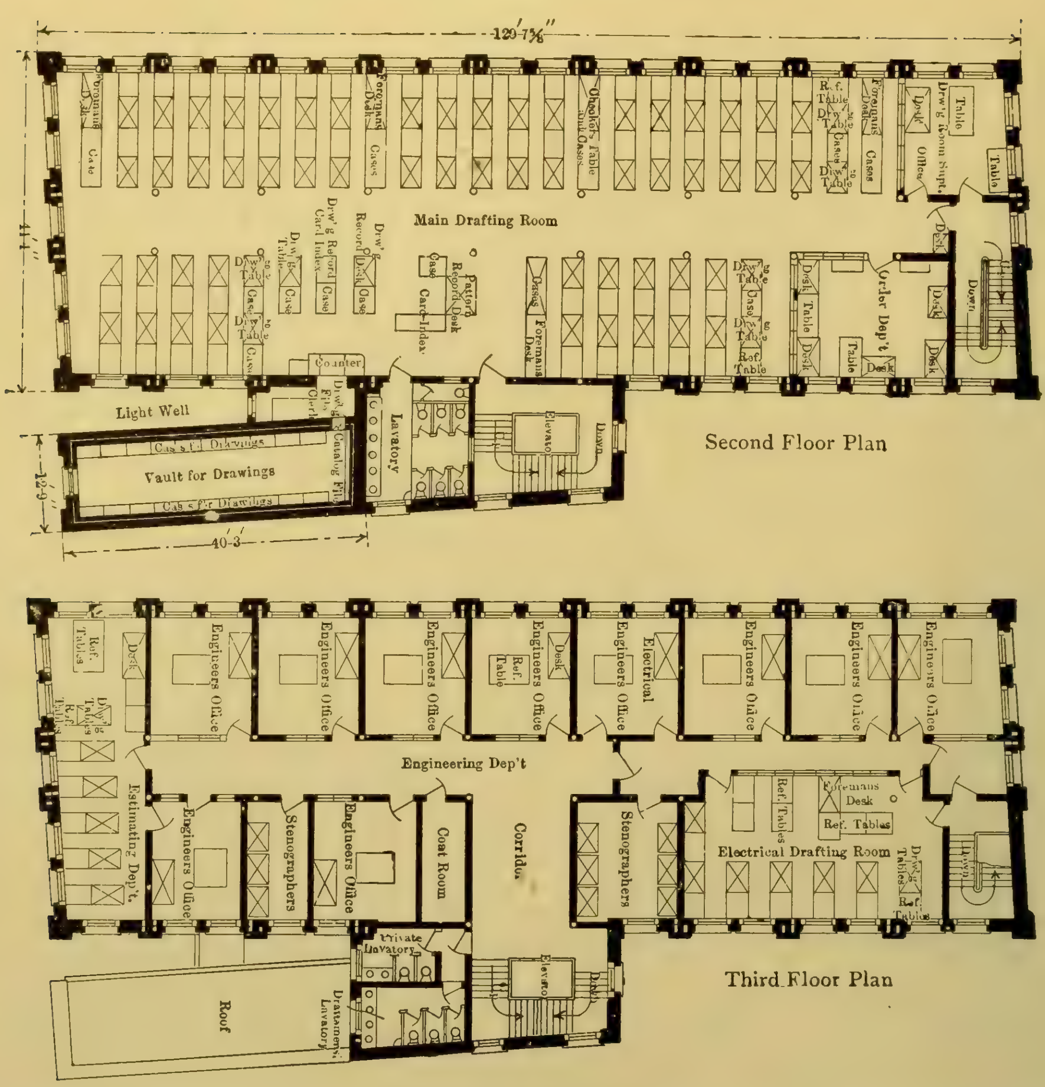
By L. D. Burlingame.

Logically, the drafting department should take its place early in the consideration of a thoroughly efficient system of shop management. Chronologically, however, the policy which Mr. Burlingame advocates belongs quite to the modern era. It is one of the features of practice which strikes Continental engineers, at least, as most distinctively and characteristically American. It is especially interesting to have it discussed by one who has been identified with notable success in its administration.—THE EDITORS.



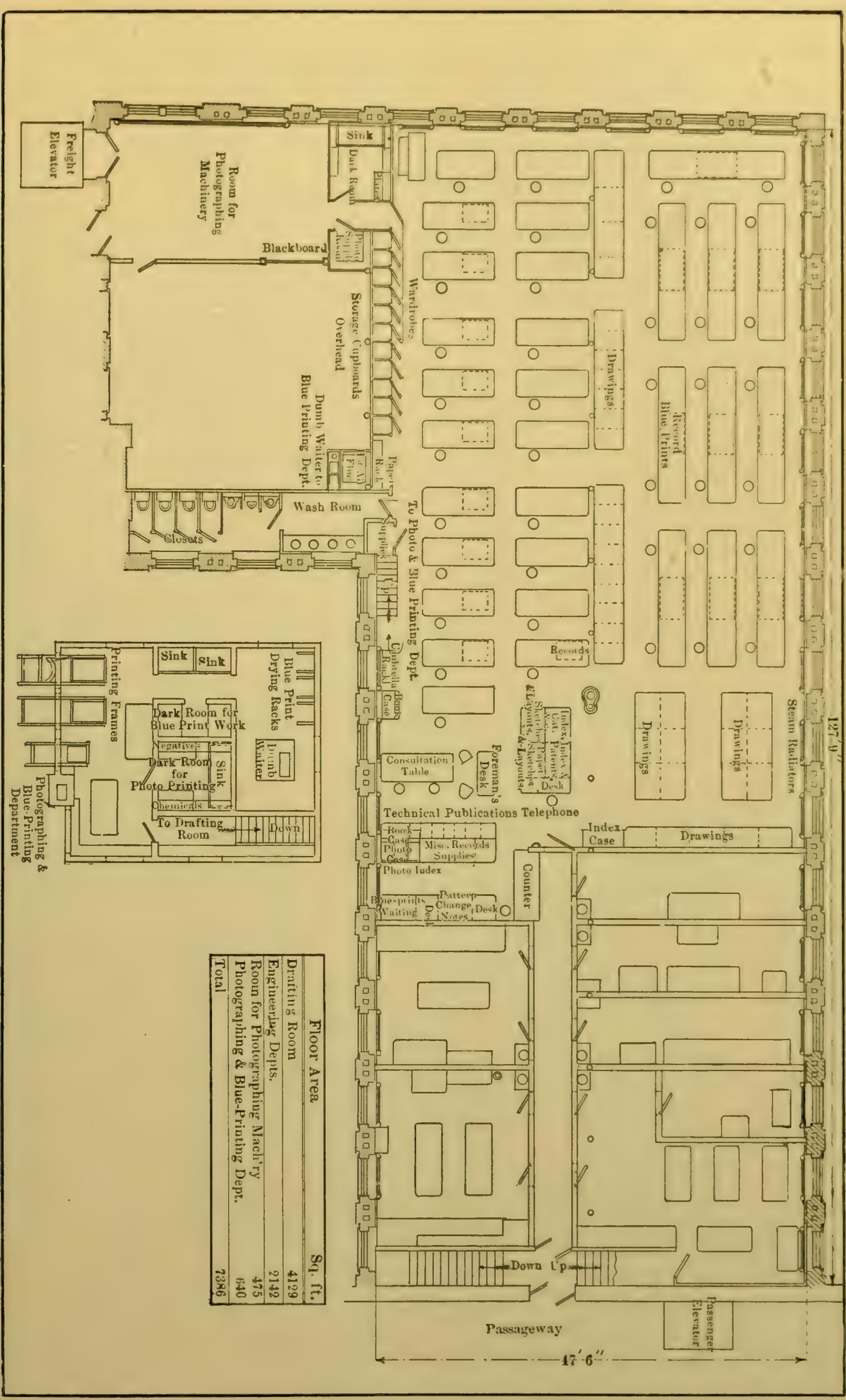
TO insure full success in any mechanical enterprise, at least two elements must be prominent: first, business and executive ability; second, engineering ability, including skill in manufacturing. What a business is in relation to its customers and the public, so, on a smaller scale—a circle within a circle—the drafting department is to the shop with which it is connected; and to secure the greatest efficiency, those elements necessary to the success of the business as a whole must be prominent in the management of the drafting department. I purpose in this paper to deal with these elements as factors in the successful management of the drafting department in its dealings with the shop.

One element of business success is to know the needs of the market; so the needs of the shop should be known in the drafting department. To accomplish this, these departments must be in close touch with each other. This makes it desirable to have the drafting room so located in the works that it will be in the midst of the shop work, easily accessible to the workman, and where the draftsmen can readily follow the work during its progress through the shop. Much of the business of the shop with the drafting department can be done over a wide counter at the entrance to the drafting room, with an electric call bell to signal such draftsmen as are often wanted. The draftsman should be ready to consult the shop man regarding all matters where his practical advice will be helpful. The shop man should



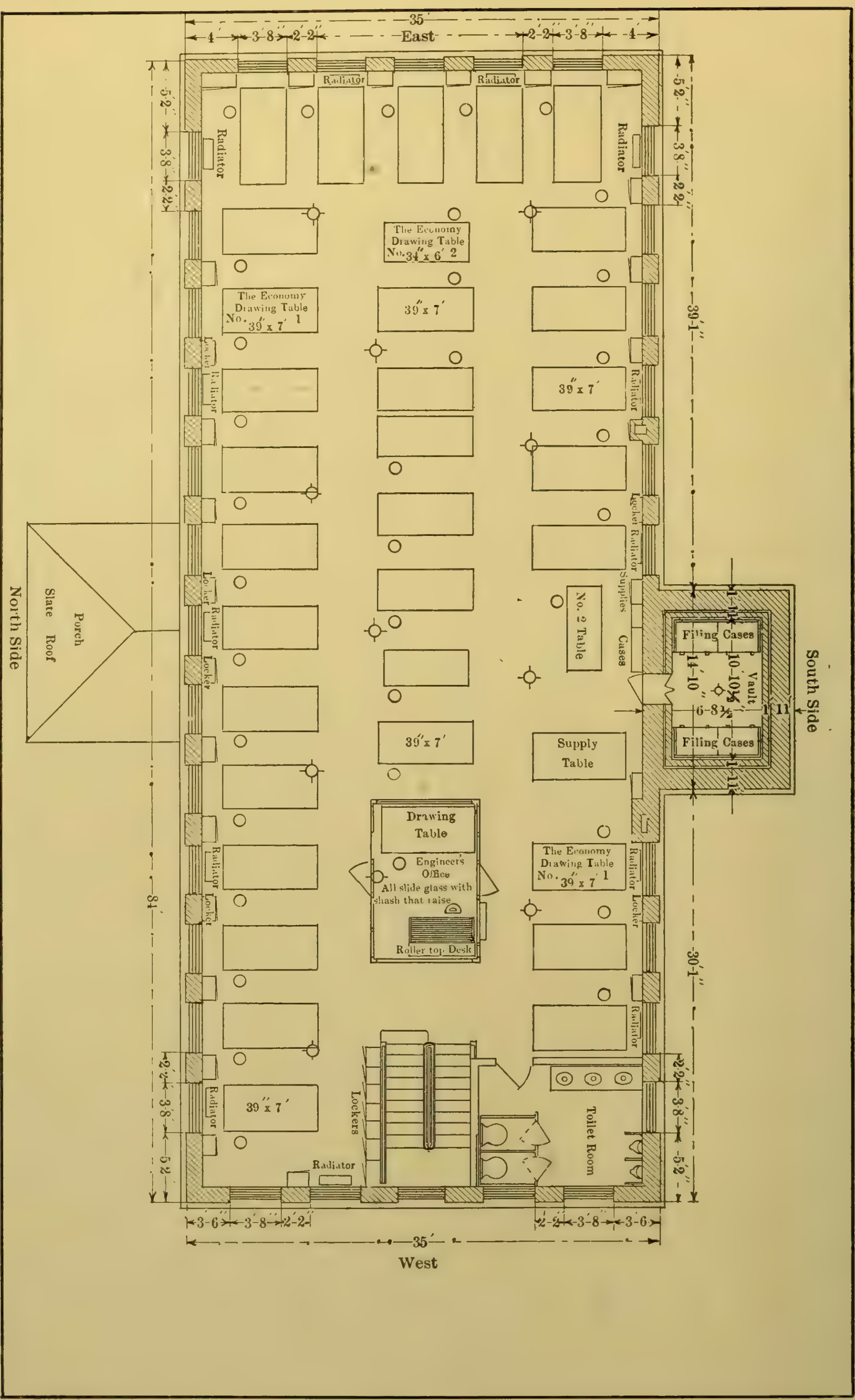
GENERAL PLAN, ENGINEERING AND DRAFTING DEPARTMENTS, WELLMAN-SEAVER-MORGAN CO., CLEVELAND, OHIO.

also be ready to point out difficulties and to make suggestions, not in a spirit of fault-finding and criticism but in a spirit of helpfulness. In all such dealings, the personal element should be entirely eliminated. It is a matter of satisfaction when questions can be considered on their merits and not degenerate into personalities, as is so likely to be the case. I remember when working over the drafting board as an apprentice, a question of design was under consideration, several men being in consultation at my board. I said, "Mr. ——— suggests such a method." One of those in consultation at once spoke up and said sarcastically, "Who is Mr. ———?" I began to explain but this man would not give the suggestion consideration because Mr. ——— held a subordinate position. This may be a glaring case but the same spirit keeps cropping up in one form or another, no matter how



Floor Area	Sq. ft.
Drafting Room	4129
Engineering Depts.	2142
Room for Photographing Mach'ry	475
Photographing & Blue-Printing Dept.	640
Total	7386

ARRANGEMENT OF DRAFTING ROOM, BROWN & SHARPE MFG. CO., PROVIDENCE, R. I.

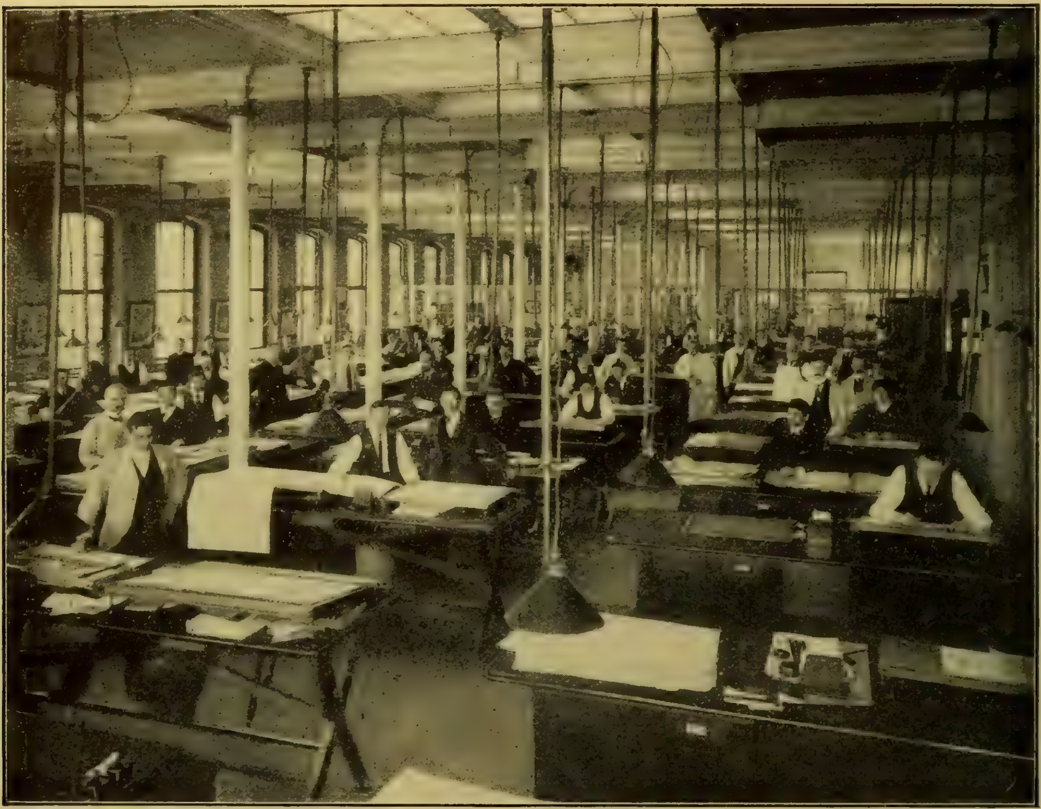


DRAFTING ROOM, TOLEDO PLANT OF AMERICAN BRIDGE COMPANY.

vigilant the management of a shop may be to prevent it. The establishment where such a spirit starts at the top of the organization and permeates it throughout is in a bad way, indeed. Even if, owing to the genius of one man, it can hold together, it will topple and go to pieces as soon as he is gone. Consideration for others in the relations between the drafting department and the shop, between the departments of the shop, and between individuals, from the highest to the lowest, is given far too little attention as a factor in economical shop management. I have known good men, profitable to their employers, to leave their place of employment, not because of being underpaid but because of annoyances or misunderstandings with foremen or fellow workmen.

This leads me to the point that the cultivation of a spirit of courtesy among the workmen and their foremen will prevent petty tyrannies and jealousies, and will not only help to keep men contented, but will make them ready to give their employers and fellow workmen the full benefit of their experience and skill. At one time we had some large forging drawings returned to the works and the order-clerk, into whose hands they came, told his errand boy to "take them to Burnham" (one of the foremen). The boy looked in astonishment but upon a peremptory order, he went off with the drawings. We missed them a day or two later and upon inquiring of the boy, he said, "You told me to take them to burn 'um and I did it." In fact, he had taken those drawings to the boiler room and had them burned, all because the order-clerk forgot to use the "Mr." when giving his instructions. I do not wish to be misunderstood as saying that putting on the "Mr." makes all the difference. It is, however, the spirit of consideration lying back of it that helps to smooth over many hard places.

There are no departments between which there is more chance of a misunderstanding, resulting in friction, than between the drafting department and the shop. In order that the work of the drafting department may reach the highest efficiency and the designs be worked out with the greatest economy, every effort should be made, not only to preserve harmony in the relations between these two departments, but to benefit by the ideas and suggestions of the shop. Draftsmen who have had shop experience are perhaps more likely to appreciate the value of such help and supplement their own experience by that of the men actually doing the work. The draftsmen without shop training, needing such help most, are usually the last to avail themselves of it. In training apprentices in drafting, it is great help to them if shop work is made part of their regular instruction, giving them an insight into shop methods and requirements, experience in handling tools, and thus a better conception of the labor-saving requirements of the shop. The Brown & Sharpe system of apprenticeship for draftsmen, as described in the January number of THE ENGINEERING MAGAZINE, has these objects in view. In many matters that come up for consideration in the drafting room, the machinist should not only be consulted but his judgment should have deciding weight. He is constantly with the work and knows where expensive fitting is required and where repairs are frequently needed; he appreciates where expenses can be reduced by the use of special tools.



THE DRAFTING ROOM OF THE BROWN & SHARPE CO., PROVIDENCE, R. I.

It is a problem to keep track of the many suggestions coming up, not only for improvements in design and for reduction of cost but for the correcting of errors or inconsistencies—suggestions that keep the draftsman always on the jump and disturb him in the midst of important work. While these are annoying, they are important, especially in a large establishment where machines are built in lots. A system in use at the Brown & Sharpe works tends to reduce this annoyance and interference with other work and at the same time to insure having all such points carefully attended to. Every foreman and responsible workman has a stub book in which he enters suggestions for such changes as seem desirable, and sends the notes to the drafting room. These notes are filed as they are received and

THE UPPER VIEW SHOWS THE DRAFTING ROOM IN THE EAST PITTSBURG WORKS OF THE WESTINGHOUSE ELECTRIC & MANUFACTURING CO. THE LOWER ONE IS THE DRAFTING DEPARTMENT IN BUILDING NO. 2, GENERAL ELECTRIC CO., SCHENECTADY, N. Y.

CORNER OF DRAWING OFFICE, NEW WORKS OF MELDRUM BROS., LTD., TIMPERLEY, NEAR MANCHESTER.

Showing vertical drawing boards in use.

attended to collectively as each lot of machines is ordered. This system encourages mutual helpfulness between the workman and the shop and the drafting department, for it makes the men feel that their suggestions are given consideration. It also gives the draftsman suggestions helpful in his future work.

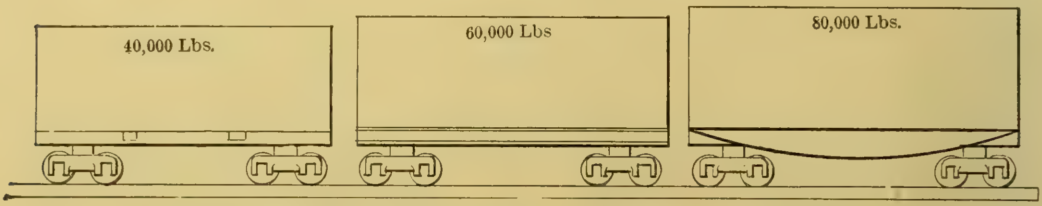
There is a great difference between so-called "red tape" and a thorough system carefully planned and perfected from time to time to suit it exactly to the needs. A shop manager recently told me that, in considering a drafting-room system, he drew the line short of one that required "an index of the index." There is an important truth here in a nut shell. Those that have had experience in systemizing work know how easy it is to lose sight of the main object to be attained, allowing it to become buried under the complications and expenses of the system, instead of being kept constantly in view. There are manufacturers who have had sad experiences with impractical or badly managed systems, and hence who denounce all systems as "red tape." A shop trying to run without system, however, is as much handicapped in competition with one well organized as a mob is against a trained army.

Any system to be efficient must be enforced. When the best business judgment has determined on a system to be used, unless the executive authority works with it hand in hand to see that it is enforced, failure may result, no matter how good the system; and the system may be unjustly blamed. If impractical, the quicker it is known and abandoned the better. This end can best be reached by prompt enforcement. Gen. Grant has said, "I know of no method to secure the repeal of bad or obnoxious laws so effectual as their strict construction," and this is exactly applicable to shop systems.

Drawings should be followed: failure to follow them is one of the greatest causes of trouble between the two departments. If a drawing is wrong, it should be changed before the work proceeds; but the drawing should be authoritative and the workman should so understand it. It will be helpful in carrying out this plan if the draftsman is willing and prompt to make such necessary changes and corrections as are suggested, leaving no excuse on this score for work to proceed contrary to the drawings. Modern practice requires that the drawing shall be made complete, all parts fully detailed with full instructions. It is desirable to have standard work detailed with one piece on a sheet so that the drawing may accompany the work through

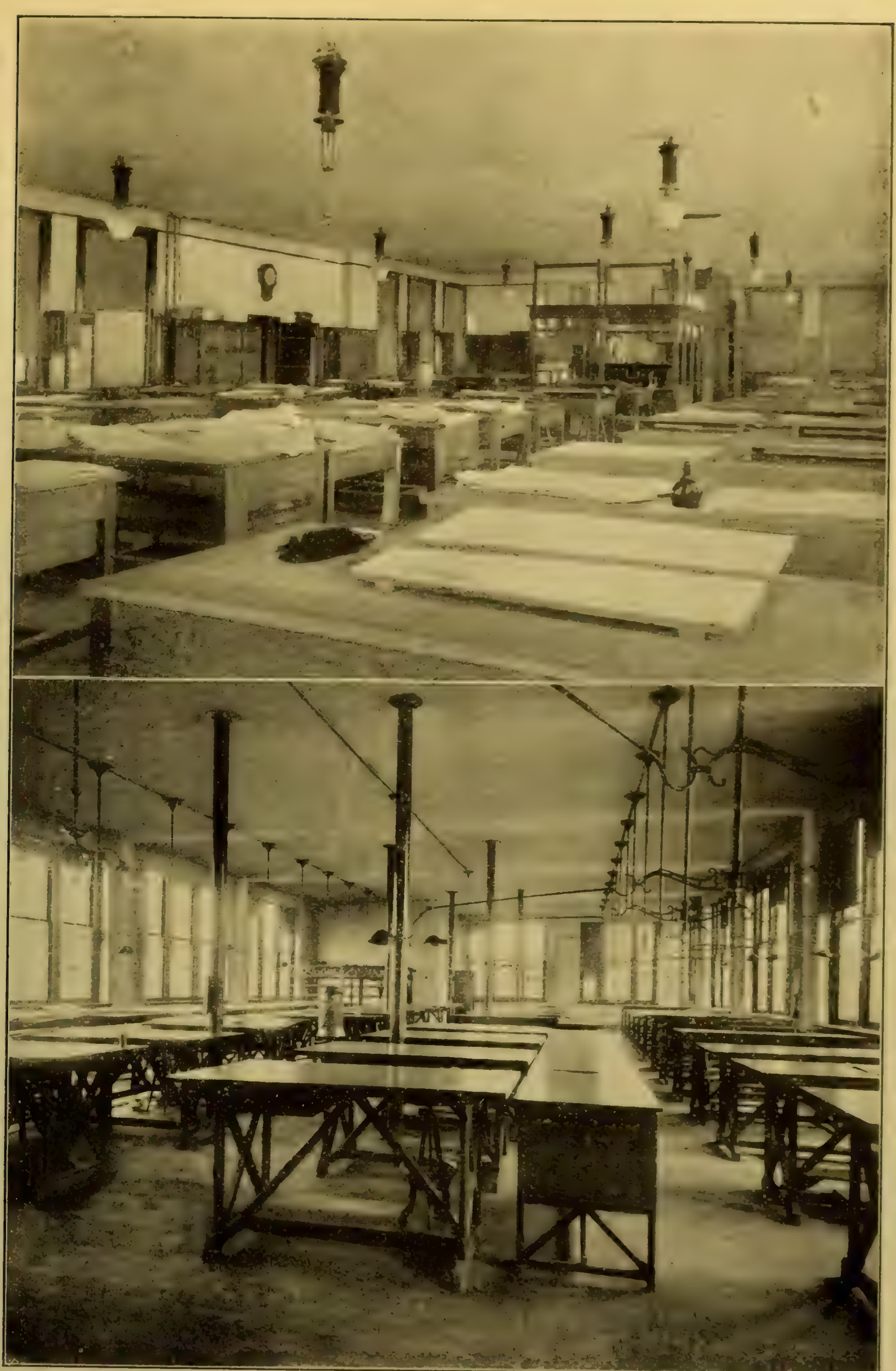
GENERAL DRAFTING ROOM IN THE WORKS OF MESSRS. GRAHAM, MORTON & CO., LEEDS.

all departments. Special books, containing lists of tools that are in use about the works, such as taps and reamers, should be available in every department of the shop; also lists of all screws and small parts carried in stock. Complete records of this sort reduce the amount of information necessary to give on the drawings. It is important that there be a distinct division of authority. It shows trouble at the fountain head, when, after errors and delays have occurred, each man concerned says, "I did not know I was expected to look after that." Somebody is responsible, and the division of responsibility should be sc clearly understood beforehand that there can be no such excuse.



AN ILLUSTRATION OF MODERN PROGRESS IN ENGINEERING.

So far I have shown some of the ways in which the business and executive handling of the drafting room can increase its efficiency by making shop skill and experience more available. Engineering ability is an equally important factor, and a progressive spirit in the engineering department is necessary to keep up with the march of events. I saw a good illustration of this a short time ago, when waiting for a train at a way station. On a siding stood a train of freight cars and of the three directly before me coupled together, one was marked 40,000-pounds capacity, having old fashioned wooden beams above the trucks; the next one, having 60,000-pounds capacity, had steel I beams; and the third car had trussed supports, giving a capacity cf 80,000 pounds. Here were the old and new, illustrating the great steps of progress during the last few years and suggesting the engineering possibilities of the future. Engineering and shop skill may, in exceptional cases, be attained by intuition and by a process of learning from the top down; even in the best of such cases the path is strewn with expensive mistakes due to lack of experience and immature judgment. In fact, all experience is made up in some measure by learning, through one's own mistakes and the mistakes of others, what *not* to do. The well established and safe way is to begin at the bottom and work up by patient and long continued study and experience gained by actually performing the operations in the shop—in the foundry, the smith shop, and the various departments of the machine shop. Even the specialist needs to be a broadly trained man, especially when he is working alone and dependent wholly on his



ABOVE IS THE DRAFTING ROOM, TOLEDO PLANT OF THE AMERICAN BRIDGE CO.; BELOW, THAT OF THE PITTSBURG OFFICE OF THE M^{C}CLINTIC-MARSHALL CONSTRUCTION CO.

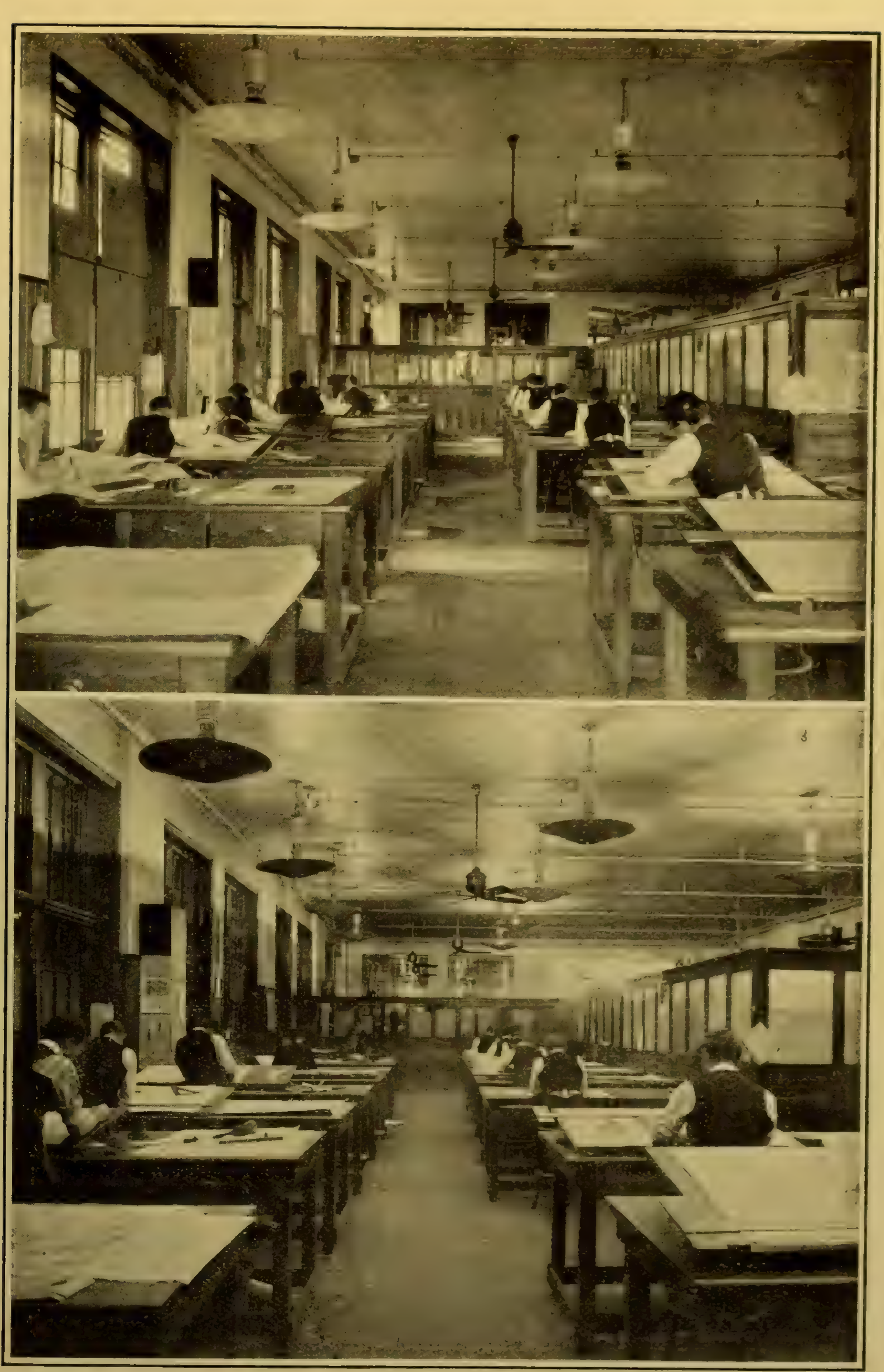
The American Bridge Co. room has the upper sash of all windows filled with factory ribbed glass; artificial lighting is by eleven lamps. There are practically no shadows, and the inner tables are almost as light as the outer. The McClintic-Marshall room is characterized by high ceilings and adjustable electric lights at every table; walls and ceilings are light blue, aiding in reflection and diffusion of light. Rear left corner of each room is a fireproof vault for storage of tracings.

own resources. In a large engineering department, the organization may be such that at least one man is expert in each of the main branches of mechanical work. The force should include technical men (the more practical the better) to help in applying theoretical problems to everyday work, and practical men (the more theoretical the better) to apply the test of experience to the problems that may arise and to puncture many a bubble of fallacy as soon as it is blown. My experience has been that the best help on technical problems arising in the shop has been given by practical men who have obtained their technical training self-taught, through long years of finding out, as the needs arose, how to do things. I do not say this in disparagement of the technical schools—they are doing a good work—but simply to point out that school work does not take the place of real experience.

DRAFTING ROOM, THE WELLMAN-SEAVER-MORGAN CO., CLEVELAND, OHIO.

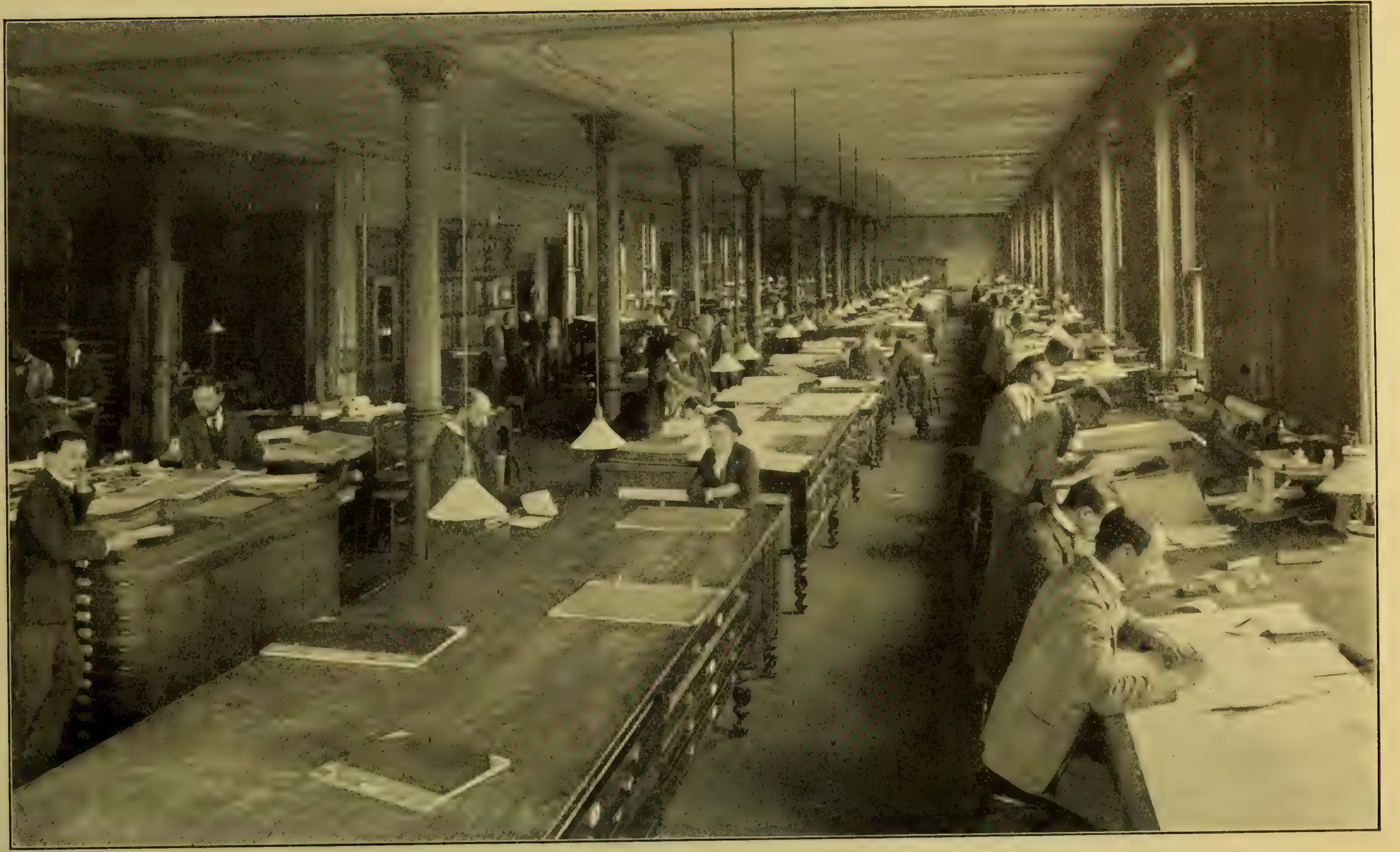
The chief draftsman under whom I learned the trade, said that if he were to train a boy as a draftsman, in seven years of preparation he would give him four years in the shop and three in the drafting room. Many of the best draftsmen have had extended experience in the shop. The work of pattern inspector gives the draftsman a good understanding of pattern and foundry work, both of value.

It is a common failing of humanity that "familiarity breeds contempt." When, on close acquaintance, it is found that the shop man



THE TWO VIEWS OF THE DRAFTING ROOM OF THE LINK-BELT ENGINEERING CO., SHOWING EFFECTS OF LIGHTING.

The upper picture was taken by daylight, the lower by artificial light. The light is thrown up against the ceiling by reflectors, and the diffused reflection thus secured gives a very uniform illumination.



THE DRAFTING ROOM OF THE BALDWIN LOCOMOTIVE WORKS, PHILADELPHIA, PA.

does not know some things the draftsman knows, because perhaps his spelling or grammar may be at fault, it is not a sufficient reason why the draftsman should despise his opinion and advice. When the draftsman comes to the machinist or shop foreman with a question or suggestion showing lack of shop knowledge, it is a short-sighted man who will jump to the conclusion that because this draftsman does not know some particular point which the machinist has learned by experience, therefore he knows nothing. A broad-minded, helpful spirit on both sides will lead in time not to contempt but to mutual confidence and reliance. I sat in our State House a few days ago during a session of the legislature in company with our general foreman, and after witnessing a stormy session, showing both energy and ability on the part of the legislators, I asked him how he would like to run a machine shop with that force of men. The look he gave me was significant; no words were needed. It was not necessarily a reflection on the men before us either; it simply recognized the difference, the incongruity of expecting one man to do another's work.

The man in the shop may laugh at a new boy from the drafting room, when, having been cautioned at home to be sure to keep away from the machines so that he would not get hurt, he edges away, with his coat gathered closely about him, from a machine that is not belted up and cannot run. The draftsman has to restrain his smile also when suggestions of perpetual motion and of kindred nature are proposed to him in the shop. It is a clear-headed man in either department that in the discussion of ways and means or the working out of complicated mechanisms always avoids such pitfalls. Conference between the two departments often shows up such fallacies. Explaining a design so clearly that others can understand it prevents them from creeping in.

There is a tendency in the shop to look with favor on the "Rough and Readies"—the Zachary Taylors of the shop, with their blunt ways and quick understanding of the requirements, and with distrust on the "fuss and feathers"—the Winfield Scotts, who are more for form and system but who may be just as useful and display even greater ability. This feeling has to be taken into account when dealing with workmen, and the recognition of it helps many a designer to get valuable information and help, by fraternizing with the men of the shop in their own way.

If a draftsman asks himself certain questions about each design or drawing he makes or checks before it leaves his hands, much shop criticism may be avoided. Among such questions are these:

Are there sufficient clearances and no interferences?

Are the castings so designed as to be readily moulded?

Can parts be practically machined; can they be assembled?

Are the worms, clutches, etc., the correct hand to give the required direction?

Are the necessary figures all given, and are they so given as to be of most help to the workman?

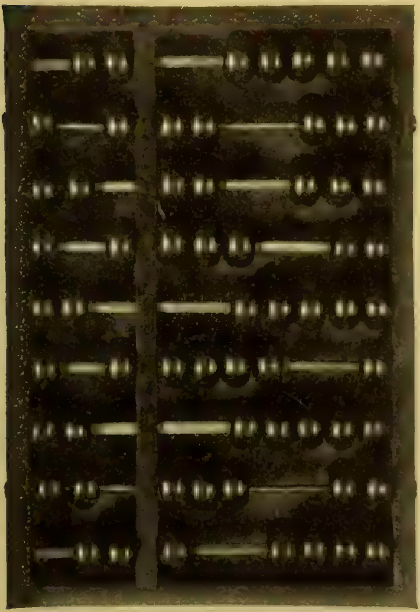
These may not be exactly engineering questions, but neglecting them may result in engineering failures. There are certain methods used in drafting, conventional ways of showing things, that the shop man should know as part of the A B C's of his calling. He cannot intelligently work from drawings unless he can read them. A failure to understand some of these simple rules may lead to the spoiling of expensive work; the cutting of clutch teeth the wrong hand, the turning down of a shaft where it is meant to be flattened only, and other like mistakes. That the workman may not be misled, the draftsman should employ uniform methods throughout his work.

A wide and varied experience covering engineering work, shop work, foundry and pattern work, architectural work, and patent-office work, can hardly be expected to be highly developed in one man. Among the advertisements in our mechanical papers for help, about all of these lines of experience have been called for in one man and he must be a young man at that. The advertiser, moreover, sometimes expects to get such help for little more than journeyman's wages. When employers have such distorted ideas, they are in danger of getting very superficial help. Stability is a quality of great value in a drafting-room force—long enough service in one place to have become familiar with its needs and to have insured such confidence as to be entrusted with responsible work. Draftsmen, as a class, have the reputation of being wanderers. They think they are broadening their experience; in reality they are becoming superficial, and do not stay long enough in one place to be entrusted with such work as to give them the best experience. Whatever, in the management of a shop, tends to develop a permanent force helps to increase its efficiency. At the Brown & Sharpe works the average length of service in the drafting and designing departments, a force numbering over fifty men, is more than nine years each with this one concern, the records of some of these men being nearly forty years. Some idea can be formed of what an amount of stored-up experience this means when it is realized that it is a total of over five hundred years of experience, directly on the work of this company, in addition to the many years of experience some of these men have had in other places. Such a stored-up experience has great potential value as a factor in conducting a successful business.

MECHANICAL AIDS IN FACTORY-OFFICE ECONOMY.

By *George Harvey Seward.*

Modern business methods, requiring both mental and mechanical operations on a very large scale, have opened an opportunity for the introduction of labor-saving machinery in commercial as well as shop management. There has, however, been little attempt at any comprehensive or systematic review of progress in this line, sufficient to acquaint the manager with the various devices available for his uses. The purpose of this article and the second paper by Mr. Seward which is to follow, is to point out the directions and extent to which mechanical aids may be advantageously used in the factory office, and to give an impartial summary—necessarily brief, but intended to be as complete as conditions permit—of the whole field.—The Editors.



OFFICE work on a large scale, in its division and subdivision into departments, very much resembles factory production; each employee has only a small, unrelated portion of the work to perform. Consequently a great volume of detail in office operations is practically reduced to a factory basis; in fact, it is a question in the larger offices as to just how so simple a matter as that of making records shall be done, and every effort tends toward mechanical production. This is illustrated by the use of blanks, carefully prepared so that a minimum amount of labor is required to make the necessary record, which may be in the form of check-mark or by actual mechanical operation, such as the perforation of a card. It is eminently proper, therefore, that we consider the use that is made of mechanical aids in a factory office.

Office routine should be such as to produce a conscientious effort; therefore mechanical aids can have a moral as well as practical use, as they place responsibility where it belongs, eliminating that element which does so much to lower the efficiency of an office—friction. As an illustration of this, consider the effect a time stamp has upon an employee who is responsible for the passage of certain papers through the department in which his duties fall.

Factory-office economy is the term I have chosen into which to focus the various elements entering into the conduct of a highly organized and well-equipped, non-productive or commercial department of a factory. The present discussion will not take up non-mechanical elements. It is matters of a dynamic rather than a static nature with which we are concerned.

Specifically, the term "factory-office economy" is intended to cover the regulation of the use of appliances and materials and the provision for those conveniences and conditions which will produce the highest efficiency. A portion of our subject is included in the well-known classification of human knowledge known throughout the bibliographical world as Dewey's Decimal Classification. Class 600 of this work is *Useful Arts,* and subclass 650, *Communication and Commerce,* which in its division into nine sub-divisions, has for its first, "Office Equipment and Methods."

So far as I have been able to learn, no serious attempt has been made to subdivide 651—Office Equipment—as the other classes have been, thus indicating in some degree the state of our knowledge of the subject. I have substituted the term "office economy" for office equipment that it may include a broader field. The subject of mechanical aids in a factory office falls under the seventh division, Appliances, of the subject of office economy in a suggestive classification* proposed by me, which is further subdivided as follows:—

651.70 Appliances.
.71
.72 Mathematical Aids. Calculators.
.73 Time Appliances.
.74 Dating, Numbering, and Pricing Machines.
.75 Registering and Tabulating Devices.
.76 Graphic Aids, Charts, Routing Systems.
.77 Protective and Perforating Appliances.
.78 Mail-Room Apparatus (Addressers, etc.).
.79 Communicative Systems (Telephone, etc.).

The present article will deal with mathematical and time appliances, leaving the remaining mechanical aids for review in a succeeding paper.

Mathematical Aids.—The introduction of such modern accounting devices as card and loose-sheet systems has created a large field for mathematical aids in factory office computations. An adding machine for example, helps to develop the labor-saving features of a system of records by cards or loose sheets. Addition, indeed, makes up about 95 per cent. of all the accounting work required in a factory.

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* Author's suggestions only; not intended as authorized schedules for Dewey's Decimal Classification.

Computing machines can be used further in combined operations such as balancing and averaging accounts, discount, and computations in which a number of products are added together and the sum divided by the number of items. Such devices, it is estimated, save one-third of the mental and physical energy expended in writing. Great use for them is found in the auditing, sales, treasurer's, paymaster's, cashier's, cost, and shipping departments of factory offices, in taking trial balances, making up bank-deposit slips, balancing cash, verifying postings, making up pay rolls or sales reports, taking inventories, listing freight bills, making out monthly statements, compiling statistical work, etc.

With the aid of one of these machines an employee's efficiency is increased two or three fold, as he not only gets out more and better work, but he can do it in one-fifth the time, so he has extra hours every day which he can devote to more important matters. And these appliances further permit the use of young, unskilled help, while they yet retain a large proportion of the accuracy of high-salaried office assistants. They are thus altogether in harmony with the trend of practice in the machine shop and in manufacturing generally.

An elaborate mechanical classification of calculating machines has been adopted by the United States Patent Office for the 824 issues made (up to May 23, 1904). From the viewpoint of the user, however, a much simpler classification may be made, which is:—

1.—Listing machines, which are practically adding machines performing other operations only in a round-about way.

2.—Non-listing devices, which include:
   a. Slide rules.
   b. Stylus operated devices.
   c. Key operated devices.
   d. Crank machines for large computations.

Listing Machines.—Where the items to be added are drawn off from some record in book, sheet, or card form, it is often desirable to have a list of them as they are added up by the machine, and a reliable adding machine is as much a necessity in the modern office as is the typewriter. It adds and lists forty items per minute. Typical of this class are the Burroughs, the Comptograph, the Universal, and the Standard machines.

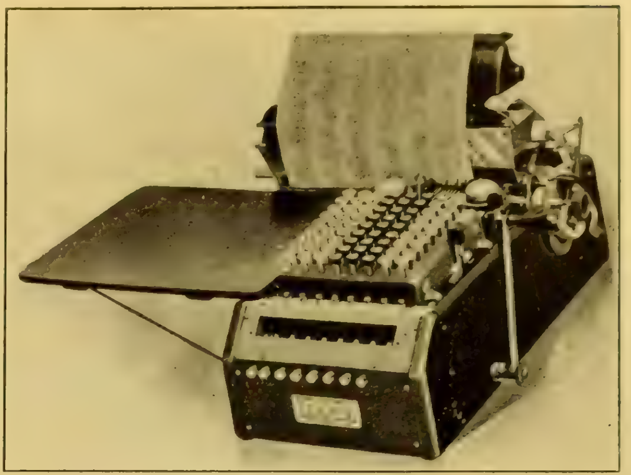
The amounts listed may be printed either on a narrow ribbon of paper or on a separate sheet like a page in a loose-leaf ledger.

BURROUGHS' "ARITHMOMETER," ADDING AND LISTING MACHINE.

Two original ink copies of the record can be made from one ribbon and one set of type on the Comptograph.

In operating a listing machine all that is necessary is to press the keys representing the amounts to be added and move a lever. The amounts are thereby listed and accumulated in the machine, and whenever desired a total can be printed by simply pressing the "total" button and moving the lever. If the operator at any time is interrupted in his work, he can attend to other matters and continue his addition where he left off, as the amounts will be retained in the machine. The majority of these machines are used for listing and adding money items, but machines are also made to add feet and inches, tons and hundredweight, hours and minutes, fractions, etc.

The Addograph is a machine used in combination with an adding machine to bring together its work and that of a typewriting machine by one operation—the nine numeral keys of the typewriter setting the eighty-one numeral keys of the adding machine. The added record is made in the adding machine and the total copied on the type-



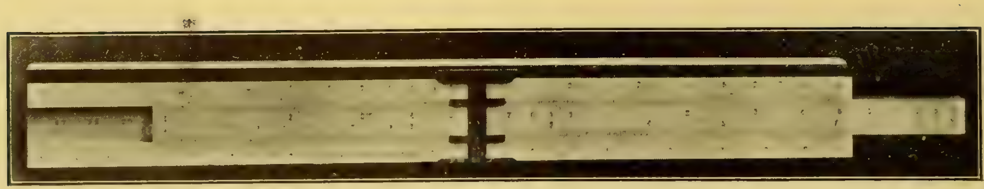
THE COMPTOGRAPH

writer. The typewriting machine is available at all times for correspondence or other work ordinarily required of such devices. This combination machine is useful for writing invoice and sales-book records by one operation.

Non-Listing Machines.—The difficulty of adding items on different sheets or cards without recapitulating them is manifest. With a machine that will add, but not necessarily list the items, they are added as easily as though they stood in a column on a sheet. Postings to a card or sheet record are checked by running the postings through a machine before the cards or sheets are filed, to ascertain if the total from the original record agrees with the total of the posted amounts.

Slide Rules.—The applications of the slide rule are as general as the fundamental rules of arithmetic. It is useful to the mechanician engaged in problems involving any of the mechanical powers, in finding the pitch and proper number of teeth, the diameter of toothed wheels, in designing machinery and in ascertaining its power. Commercially, it is useful in extending pay-rolls, pro-rating accounts, for ascertaining the weight of metals and other materials, and in the general application of multiplication, division, proportion, fractions and as a check on ordinary calculations.

NATIONAL ADDOGRAPH.



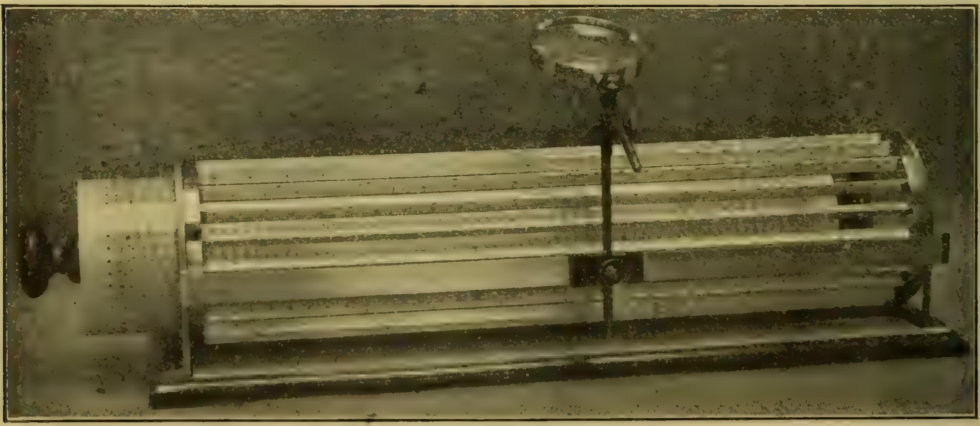
THE SLIDE RULE.

It consists of a geometrical scale of logarithms, so arranged that operations may be performed by sliding one part upon another and reading off the result graphically displayed.

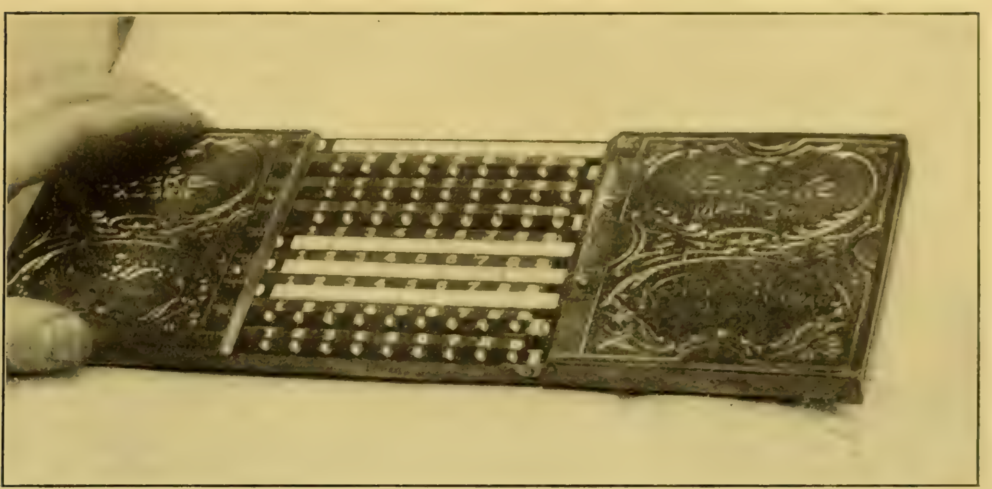
The Thatcher instrument consists of a cylinder 4 inches in diameter and 18 inches long, upon which the logarithmic scales are arranged in twenty parallel lines; the cylinder revolves within and upon a framework composed of twenty angular bars. The logarithmic scale is duplicated on the exposed sides of the bars, and a proper movement of the cylinder allows any of its graduations to be brought into coincidence with any graduation on any bar.

The Omnimetre is a circular modification of the slide rule printed on concentric cards, which is very convenient of manipulation and adapted to a broad range of mathematical operations. This tvpe of circular slide rule is the form known in the patent office as single-axis calculators. Prominent among inventors of these calculators is Carl G. Barth of Swarthmore, Pa., who has devised slide rules on which very complex mathematical problems may be solved. Of the twelve variables that enter into the problem of determining the most economical way in which to remove a required amount of stock from a piece of lathe work, all but a single one—the stiffness of the work—are incorporated in the slide rule.

The Locke Adder is a type of bar calculator. Different sliding bars represent various orders in the decimal notation, the lowest and nearest side being units, the next hundreds, and so on. The adder is operated by placing the fingers upon the knobs opposite the proper



THE THATCHER MACHINE.

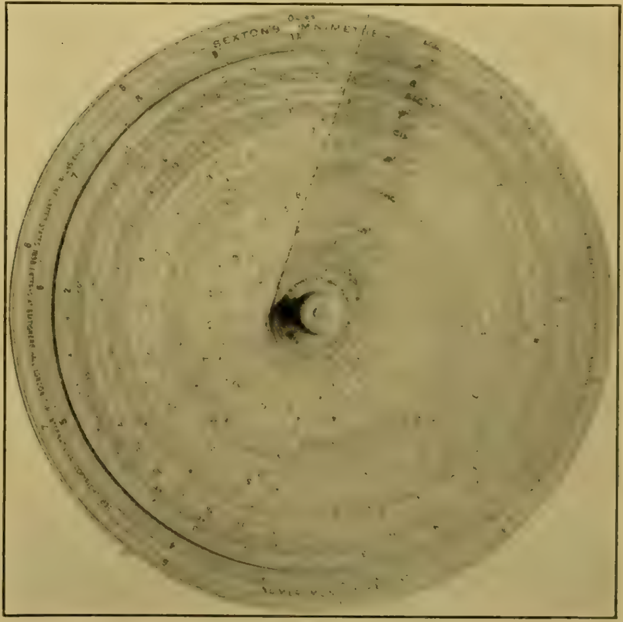


THE LOCKE ADDER.

figures and moving them to the right or left until stopped by the edge of the plate. The resultant figures are read down or towards the operator. The size of the device is about 4 by 11 by ½ inches.

A device known as the "Calcumeter" consists of a number of movable dials that can be rotated underneath a perforated plate bearing a series of stationary dials. In using the machine, it is placed conveniently near the column of figures to be added; then the units, tens, and hundreds of the first amount are registered by bringing the proper dials around with a stylus. The next amount is treated in the same manner, the machine carrying the units to tens, tens to hundreds, etc. Other dial machines are Herring's and Webb's.

The New Idea calculator is designed to exhibit ready-made multiplications occurring in pay-roll and labor-cost sheets.



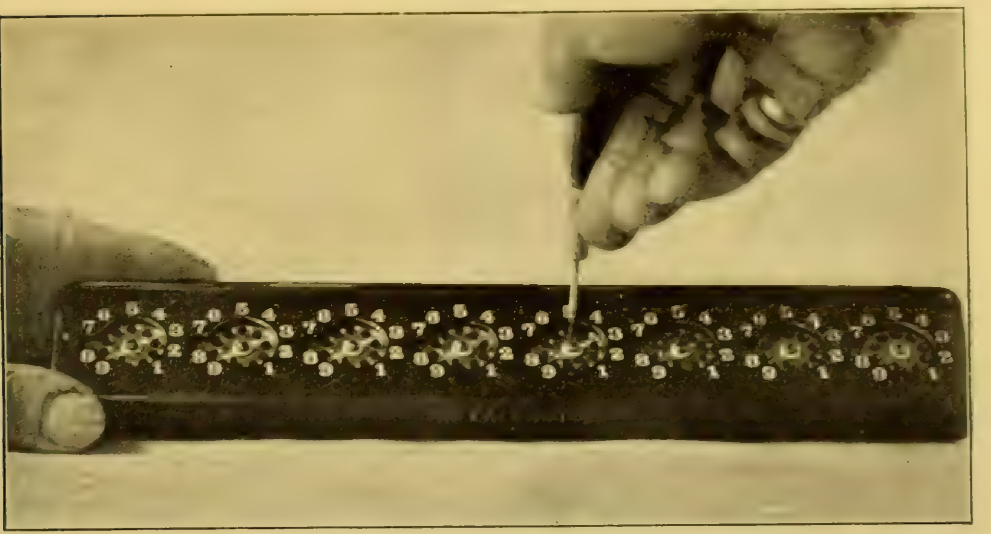
SEXTON'S OMNIMETRE. (CIRCULAR SLIDE RULE.)

The Arithmachine is a belt type of calculator in which endless chains in contact with numeral disks are operated by a stylus. This ingenious device, the invention of Henry Goldman, is operated for addition by depressing, by the stylus, at the proper point, the chain in the column corresponding to power of the figures to be registered, and drawing the chain forward. The operation is similar to making a figure "1" on paper. The device is 4½ by 1½ by ¾ inches.

The Beach machine is a compact device for addition, principally, occupying a space of about 42 square inches. The total registration of the first model is $999,999.99. Complemental figures are provided for subtraction and division.

THE NEW IDEA CALCULATOR.

The Comptometer is a key-operated machine for performing the four basic mathematical operations. On account of the large proportion of adding and multiplication in arithmetical operations, the keyboard is arranged to facilitate these operations. It is disposed decimally, the units from one to nine being in the first column, the tens from ten to ninety in the second, and so on. Addition is performed by simply depressing the keys bearing on their tops the numbers to be added. To add 568, a "five" key in the third column, a "six" key in the second column, and an "eight" in the units column are depressed, and 568 appears in the register. Multiplication is performed by taking one number on the keys and in striking it the num-

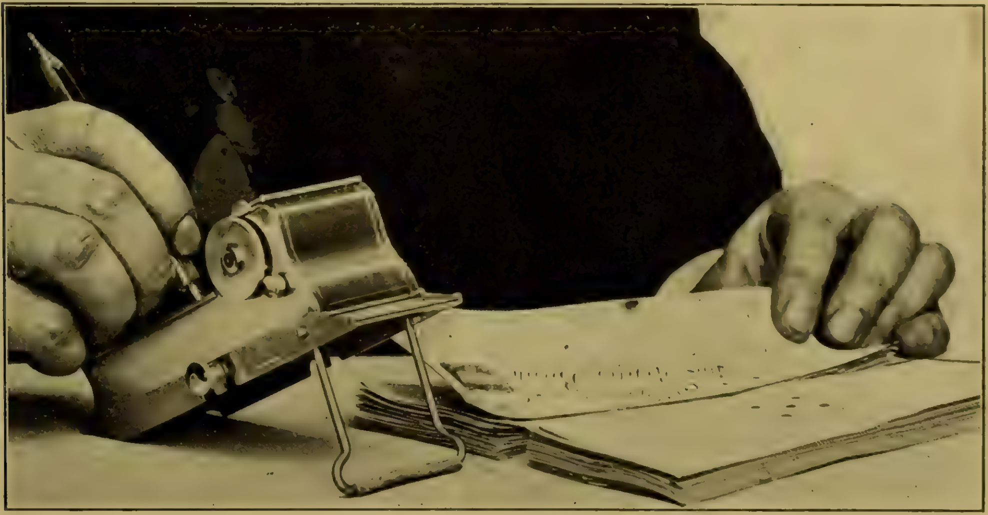


THE CALCUMETER.

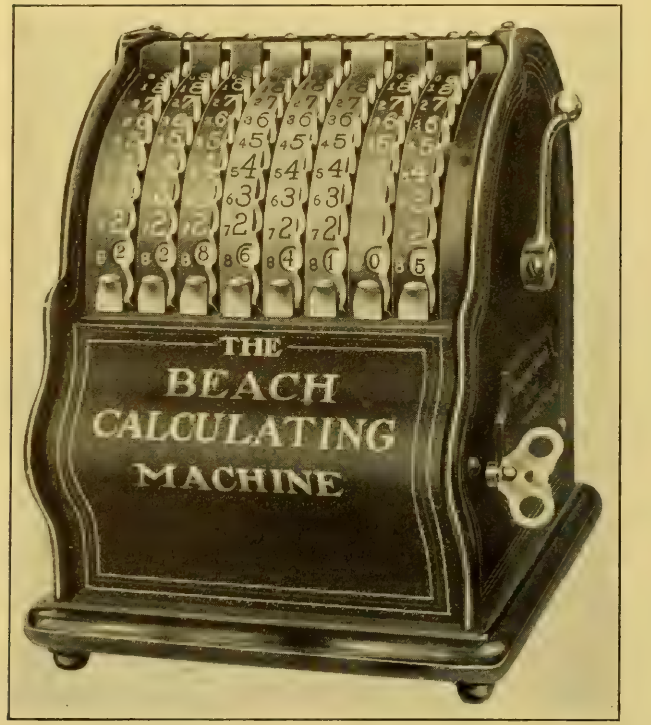
ber of times indicated by the figures of the other number in their proper position on the keyboard. On the new model any number of keys in the multiplier may be struck simultaneously. By means of complementary figures on the keys division and subtraction are performed.

The Mechanical Accountant is a combination of keys and dials and is key-operated. An original feature is a set of dials, in addition to the usual registering ones, which is operated simultaneously by the keys and indicates the particular key struck, thus enabling the operator to prove his work as he goes along. The size of the device is 13 by 8 by 6 inches; capacity $9,999,999.99.

Crank Machines.—A few years ago the use of this type of calculating machines in the United States was limited to life-insurance companies. Now their utility is being recognized in the great in-



GOLDMAN'S ARITHMACHINE.



BEACH CALCULATING MACHINE.

dustrial corporations so that importers have difficulty in keeping up with the demand. In Europe they are in quite general use. Their use by every individual clerk is not recommended so much as that by such employees as are able to review the transactions of the day intelligently, to prove their correctness.

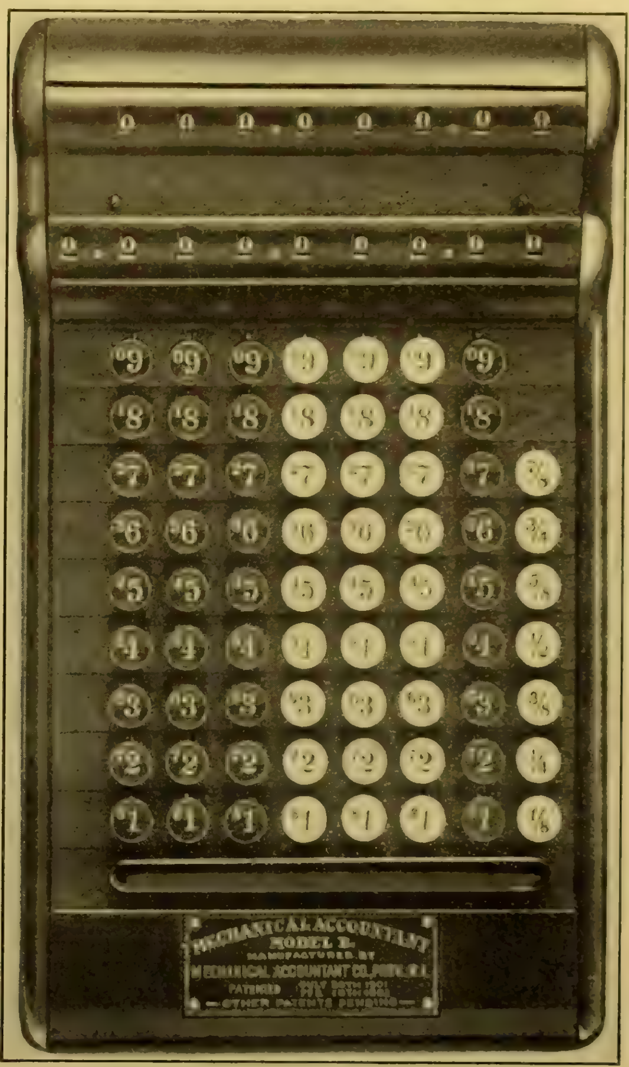
These machines are especially applicable to large work and are beginning to have a commercial use where there is work requiring a large amount of multiplication. Machines of this type, except the Baldwin, are at present imported into the United States, and are

COMPTOMETERS IN USE IN THE OFFICE OF THE ALBERT DICKINSON SEED CO., CHICAGO.

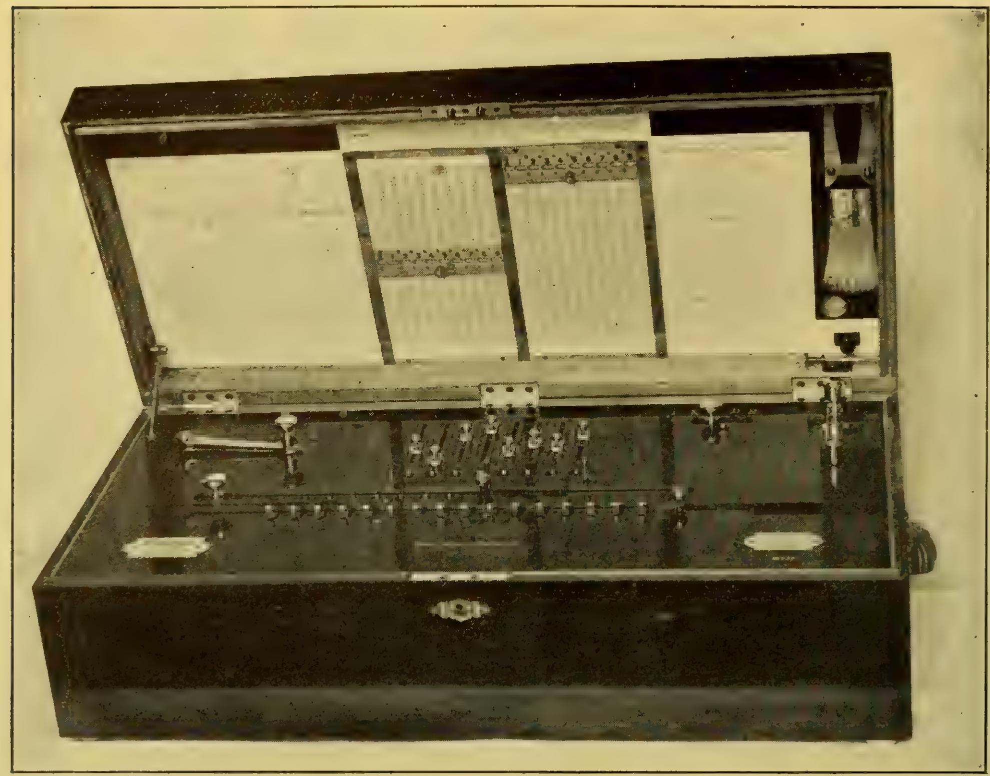
known as arithmometers or reckoning machines. Multiplication is performed step by step, using a multiplier of one figure. On most of the machines the crank handle is turned the number of times corresponding to the multiplier. To multiply by eight, for example, the handle would be turned around eight times. Different forms of these machines are:—Thomas, Odhner, Tate, Burkhardt, and Millionaire.

The Baldwin calculator is an American machine, the invention of Frank S. Baldwin, of Newark, N. J., who has been engaged in the manufacture of similar machines for over twenty years, taking out letters patent in 1875. His present machine is made under patents granted to him in 1902. It is 10 by 7 by 6 inches, has eight numeral wheels, nine figures in the quotient, and sixteen in the product.

The "Millionaire" Calculating Machine requires but one revolution of the crank handle to perform an operation. To multiply by 8, for example, a pointer is set for the multiplicand, another for the multiplier, and the crank revolved once. In a similar way division, addition, and subtraction are performed. As an illustration of the utility of this and other machines of it may be cited that it is used in the structural department of a steel company, principally in carrying out multiplication of quantities on lists of items of structural steel taken from drawings. A machine operator carries out and adds the totals on lists made by two or three other men, saving the work of one man in four or five. On more simple routine work in the same place the machine does the



THE MECHANICAL ACCOUNTANT.

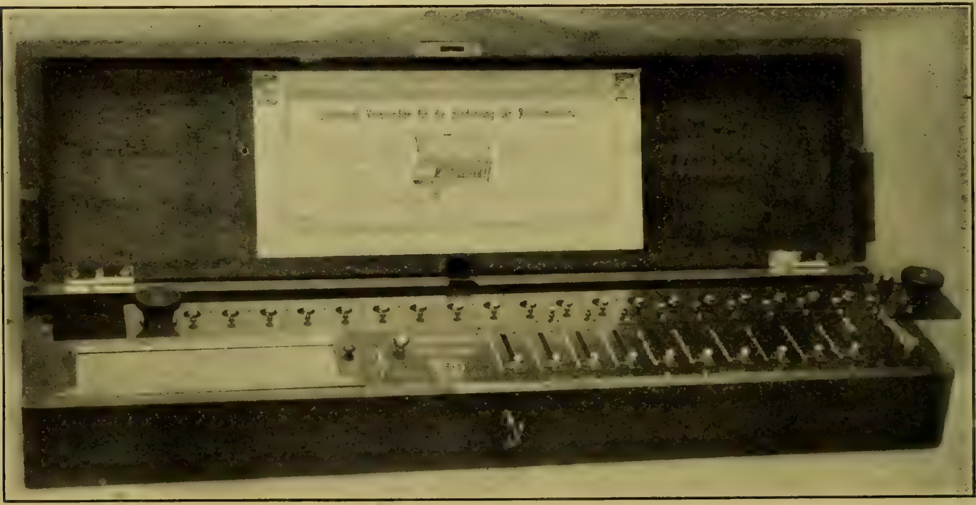


THE MILLIONAIRE CALCULATING MACHINE.

work of at least two men using the customary logarithmic or multiplication tables. The Burkhardt machine is sold in three sizes.

Registers of various types, including those for recording cash sales, and tabulating machines, have adding mechanisms but will not be treated under this heading of mathematical aids.

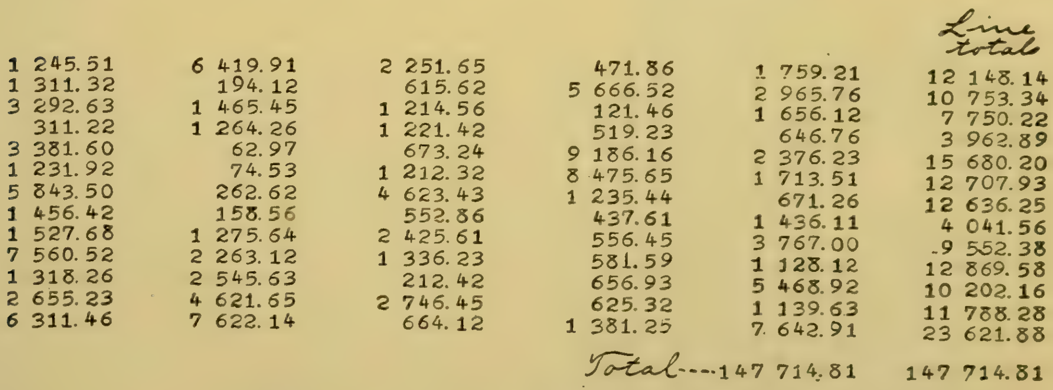
Time Systems.—Time measurement is undoubtedly the most important element in factory-office economy. As the factory records of time measurement are sent directly to the office, appliances may be



BURKHARDT'S CALCULATING MACHINE.

discussed in the broad sense independent of their location in the plant.

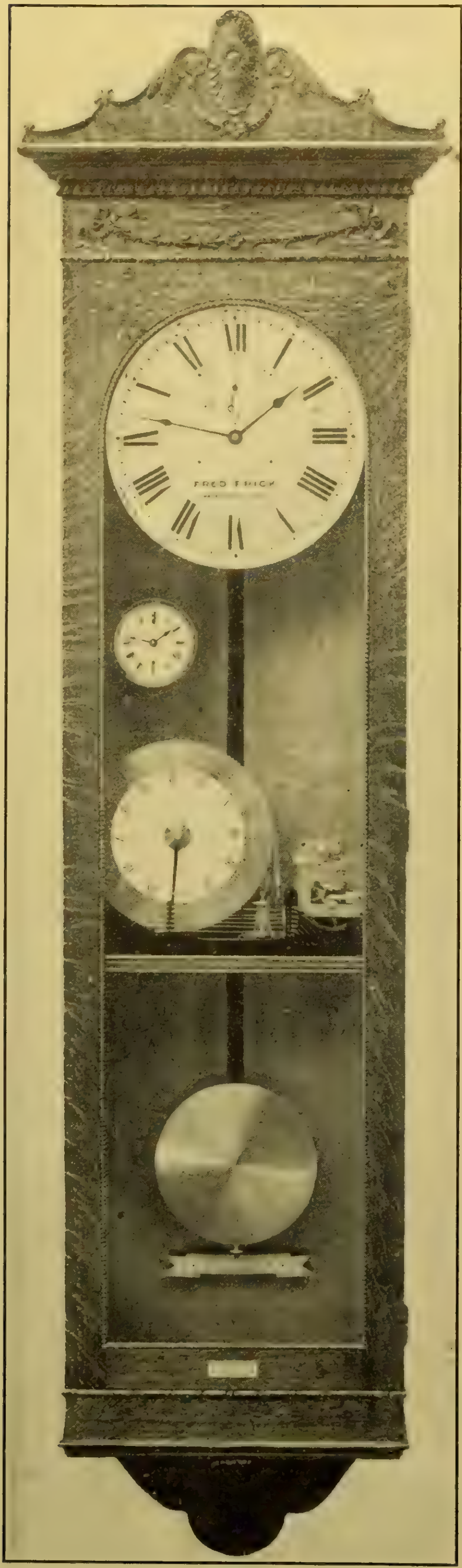
Up to 1890 there was no automatic system of time keeping employed. The old brass-check system had been used for checking men in and out of work. There was the old-fashioned timekeeper perched on a stool, pad in hand, who attempted to check the workmen as they passed through the entrance. He was sometimes late himself, and had his friends who were never docked. There was no check on mistakes, whether made honestly or through favoritism or collusion, and the employer had no evidence to offer in case of disputes. Today no argument is necessary to convince a factory manager that a time recorder is an essential part of the plant equipment. The only real question is the kind that should be adopted. During the past two or three years an additional use has been given to time recorders, and a largely increasing interest and value is now attached to time recorders in factories for determining the cost of production.



					Line total
1 245.51	6 419.91	2 251.65	471.86	1 759.21	12 148.14
1 311.32	194.12	615.62	5 666.52	2 965.76	10 753.34
3 292.63	1 465.45	1 214.56	121.46	1 656.12	7 750.22
311.22	1 264.26	1 221.42	519.23	646.76	3 962.89
3 381.60	62.97	673.24	9 186.16	2 376.23	15 680.20
1 231.92	74.53	1 212.32	8 475.65	1 713.51	12 707.93
5 843.50	262.62	4 623.43	1 235.44	671.26	12 636.25
1 456.42	158.56	552.86	437.61	1 436.11	4 041.56
1 527.68	1 275.64	2 425.61	556.45	3 767.00	.9 552.38
7 560.52	2 263.12	1 336.23	581.59	1 128.12	12 869.58
1 318.26	2 545.63	212.42	656.93	5 468.92	10 202.16
2 655.23	4 621.65	2 746.45	625.32	1 139.63	11 788.28
6 311.46	7 622.14	664.12	1 381.25	7. 642.91	23 621.88
			Total----	147 714.81	147 714.81

FAC-SIMILE OF A RECORD FROM THE COMPTOGRAPH.

The study of "unit times" is citedby Mr. Taylor as the first detail of importance in making any factory system a success. He commenced in 1883 to time with a stop watch each of the elements of the various kinds of work done in a machine shop, and then found the quickest time in which each job could be done by summing up the total times of its components parts. Afterwards he established a time-study and rate-fixing department to give out piece-work prices. Mr. S. E. Thompson of Newton Highlands, Mass., devised a watch-book and watch dial, first for himself and then for Mr. Taylor. He says that comparatively few, even at this date, realizes the absolute necessity for taking observations upon the elementary units into which operations can be divided. Even when using decimal watches and watch-books they continually neglect the necessary sub-division, and take the gross observations, so that their results are valuable only for the specific job under observation.



FRICK'S PROGRAMME CLOCK.

There are three methods of control of time appliances—mechanical, electrical, and pneumatic. The mechanical, or gravity, time device is necessarily a unit by itself, while electrical and pneumatic appliances may form a system, all the devices connected in unison and operated from a master clock.

Time devices are used for at least five different classes of work at a plant—coming-and-going, cost work, dating of papers, signaling (programme apparatus), and record of movement of watchmen. Every factory of any size has some method of keeping a record of the time each employee spends in the works. With checks, cards, and pass books for time-keeping purposes we are not concerned.

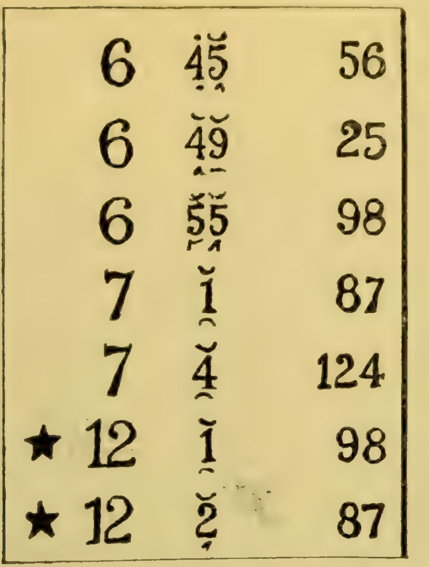
Of practical time recorders for the first two classes there are:—

(1) Key, (2) Autographic, (3) Dial and Drum, (4) Card, (5) Calculating.

Key Recorders.—With this form of recorder (for coming and going time), each employee has a numbered key with which he registers his time and number by inserting the key in the recorder.

Autograph Recorder. — For a small number of employees, the registration of their names and time is accomplished, when records in this form are desirable, by an autograph recorder.

Dial-Recorders.—For the drum-dial time registers it is claimed; (1), that the record is so arranged

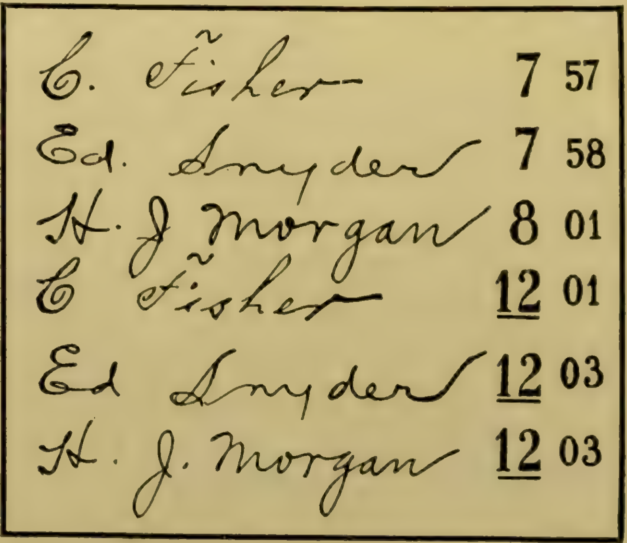


	6	45	56
	6	49	25
	6	55	98
	7	1	87
	7	4	124
★	12	1	98
★	12	2	87

FAC-SIMILE RECORD OF KEY RECORDER.

that confusion is impossible, since for each man a separate line opposite his assigned number is provided; (2), that these numbers being consecutive, a workman may make his record without reference to the man who has preceded or is to follow him. Registrations of six, twelve, or forty-two records may be had, the latter for an entire week. Where only two registrations daily are required, the recorder of twelve registrations, will, of course, last an entire week. Automatic adjustment of the "In and Out" mechanism is provided when men come and go at fixed hours.

For conditions where it is inconvenient for the time clerk to remain until the last employee has left, or to be on hand before the first employee arrives in the morning, a double drum is provided. The change of record on a register so equipped may be made the day following that for which the record was made. The machine itself changes from the first pay day, e. g. Monday, to Tuesday and registers the arrival of the employee on the Tuesday slip. To record the time of both night and day shifts, two slips are put on the drums; the latter being close together, the last registration for Monday night is alongside the first registration for Tuesday morning, so that the record for Monday and Monday night are on the Monday slip and those for Tuesday and Tuesday night are on the slip for that day.

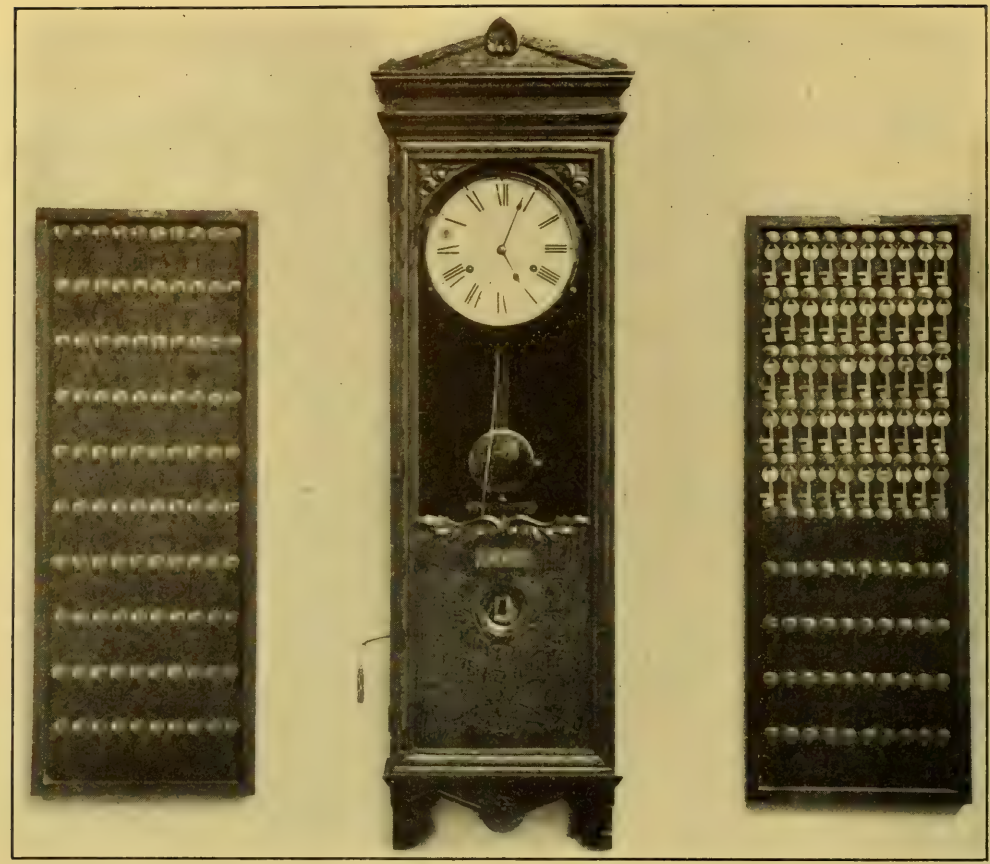


C. Fisher	7	57
Ed. Snyder	7	58
H. J. Morgan	8	01
C Fisher	12	01
Ed Snyder	12	03
H. J. Morgan	12	03

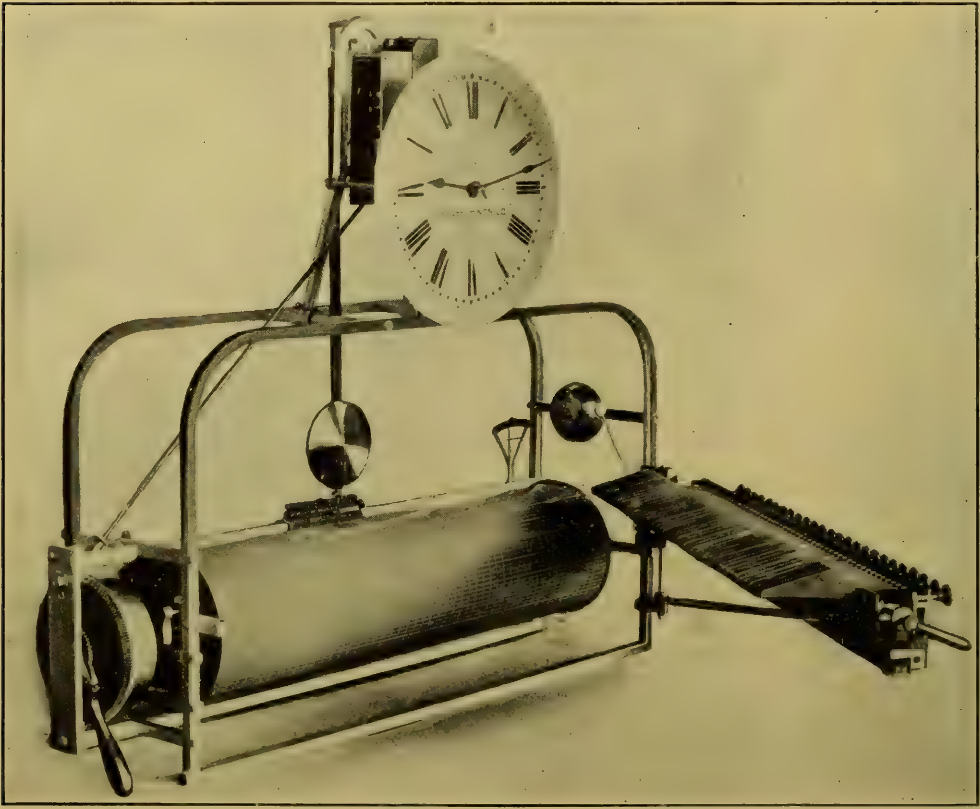
FAC-SIMILE RECORD OF AUTOGRAPHIC RECORDER.

Two-color ribbons are used to distinguish between the records of those who arrive at the proper time and those who are late, or between day and night shifts. The change is made automatically.

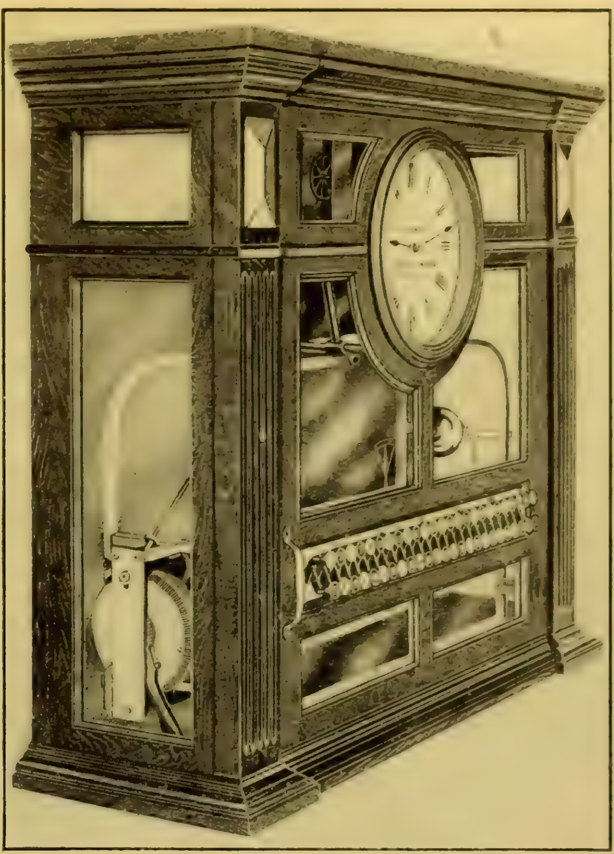
A drum register employing sensitized paper upon which individual markers trace continuous lines during the



BUNDY KEY RECORDER.



INTERIOR MECHANISM OF THE HAWLEY TIME REGISTER.

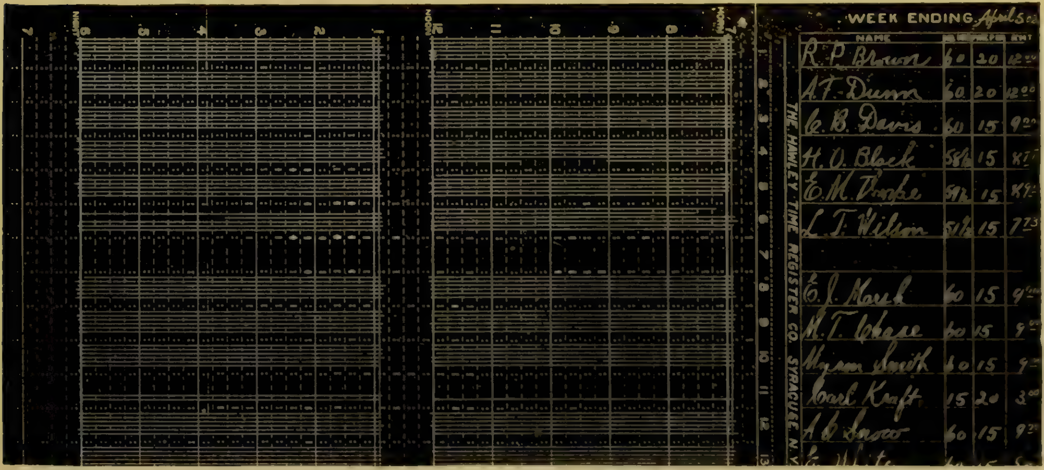


HAWLEY TIME REGISTER.

measurement of a time period has recently come upon the market. Clock mechanism controls the revolution of the drum so as have an inch on the surface (upon which the sensitized paper is wrapped) equal an hour.

Card Recorder.—The card recorder furnishes a system of keeping all kinds of time of employees. As the record is on a card outside of the clock it can be utilized with all the advantages of the card system. The operation of recording is simple and well-known. On the back of the card may be entered piece work or distribution of time on a job, concentrating at one point all details of each employee. Each kind of piece work or time spent on different orders can be entered, so that it only needs adding up at the end of the week to balance against the time recorded on the face of the card, thus saving a great amount of clerical work.

In making up the pay roll the totals only from the cards are en-

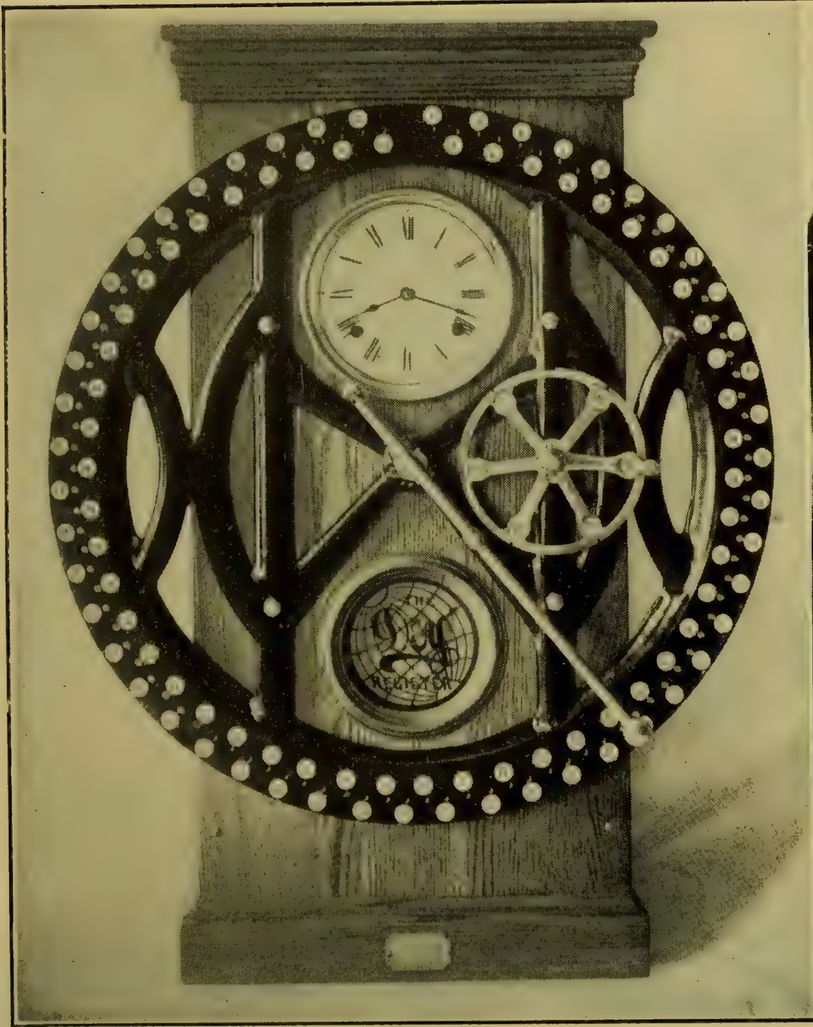


THE HAWLEY TIME REGISTER CO. SYRACUSE, N.Y.

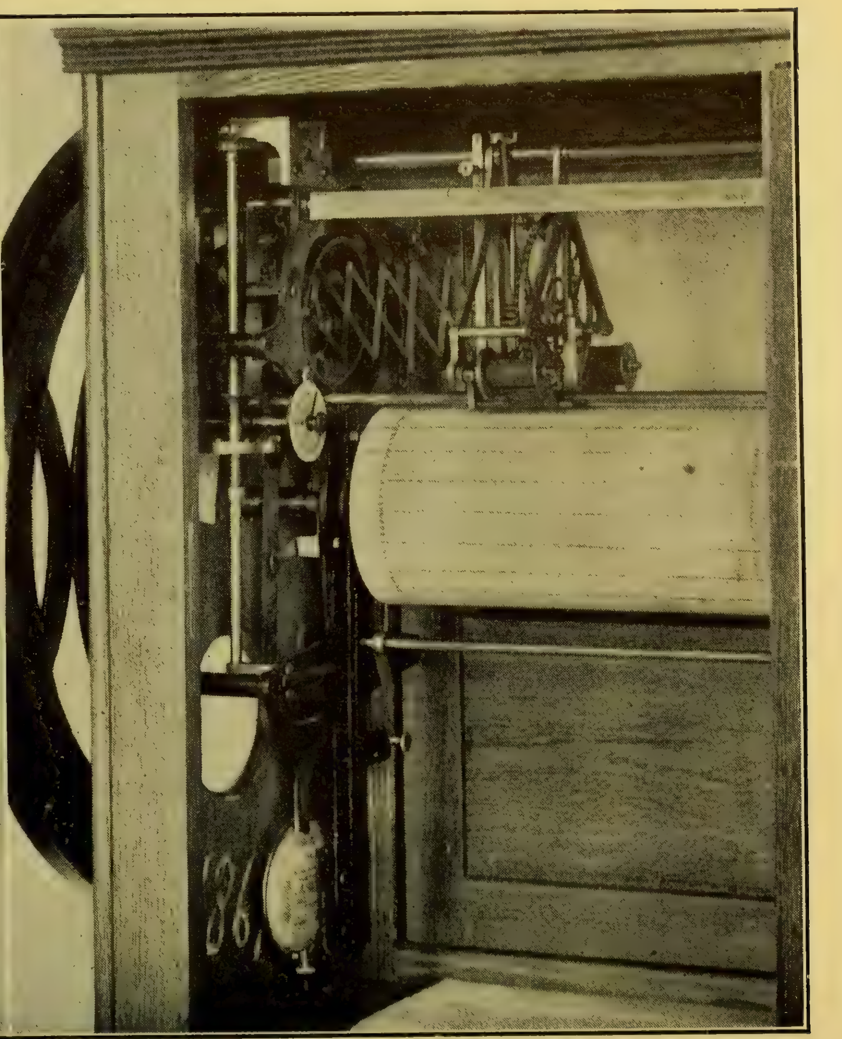
WEEK ENDING April 5

NAME	[illegible]	[illegible]	AMT
R. P. Brown	60	20	12^{00}
A. T. Dunn	60	20	12^{00}
C. B. Davis	60	15	9^{00}
H. O. Black	58½	15	8^{77}
E. M. Drake	59½	15	[illegible]
L. T. Wilson	51½	15	7^{73}
E. J. Marsh	60	15	9^{00}
M. T. Chase	60	15	9^{00}
Myron Smith	60	15	9^{00}
Carl Kraft	15	20	3^{00}
A. B. Snow	60	15	9^{00}

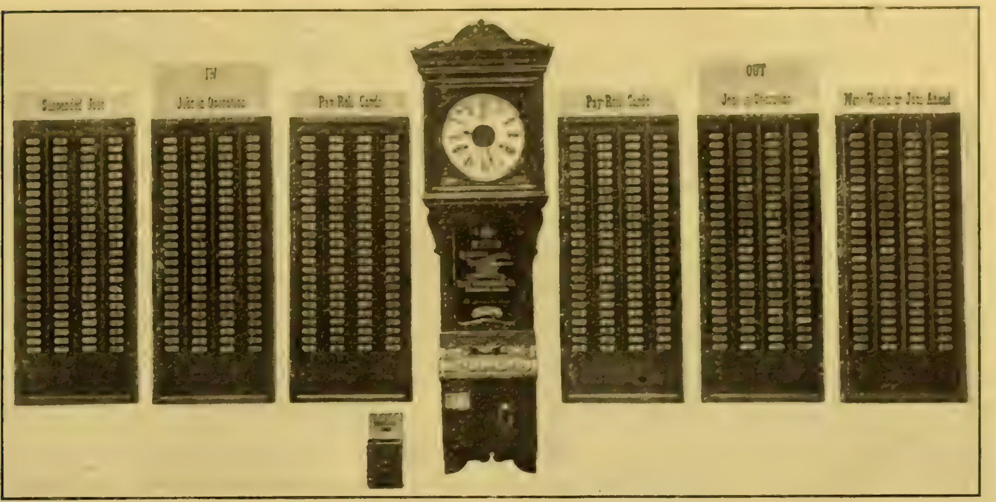
FAC-SIMILE OF SENSITIZED PAPER RECORD FROM HAWLEY TIME REGISTER.



DEY TIME REGISTER COMPANY'S DRUM-DIAL TIME REGISTER.



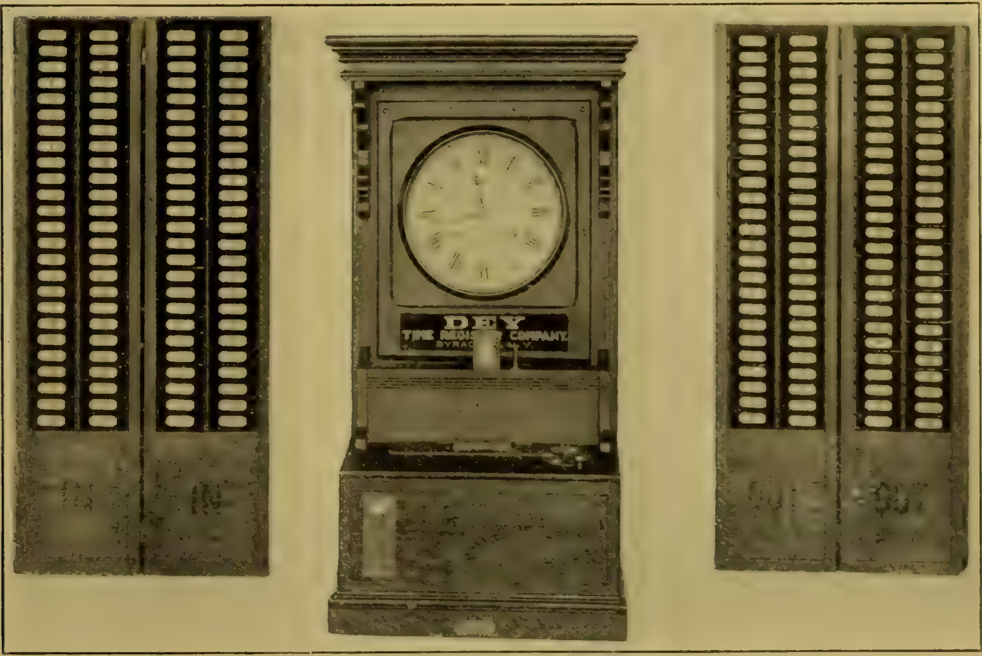
INTERIOR DEY AUTOMATIC WEEKLY DRUM-DIAL TIME REGISTER.



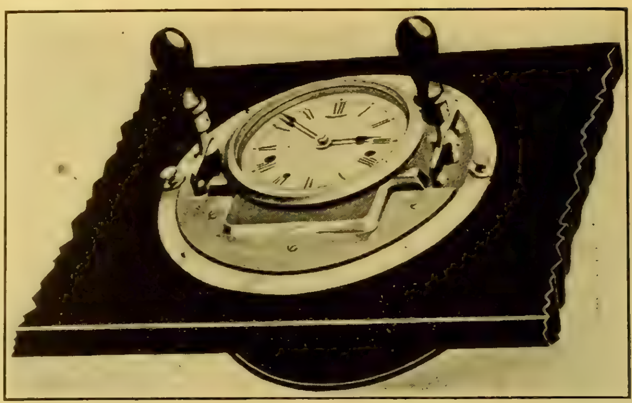
ROCHESTER CARD RECORDER AND RACKS ARRANGED FOR COST KEEPING.

tered, thus enabling a pay roll for one hundred employees, for example, to be made up in less than an hour each week.

For cost-keeping purposes, the card recorder is admittedly the best. Separate cards are employed, on which the time is recorded for each job or operation connected therewith. These cost cards are checked with the weekly time cards and this comparison exposes any errors, loss of time, or false distribution. The reasons for the adoption of a card recorder by a factory manager are given as; (1), prevention of alteration of the registered time; (2), opportunity for the employee to note personally his arrivals and departures for an entire



DEY CARD RECORDER.



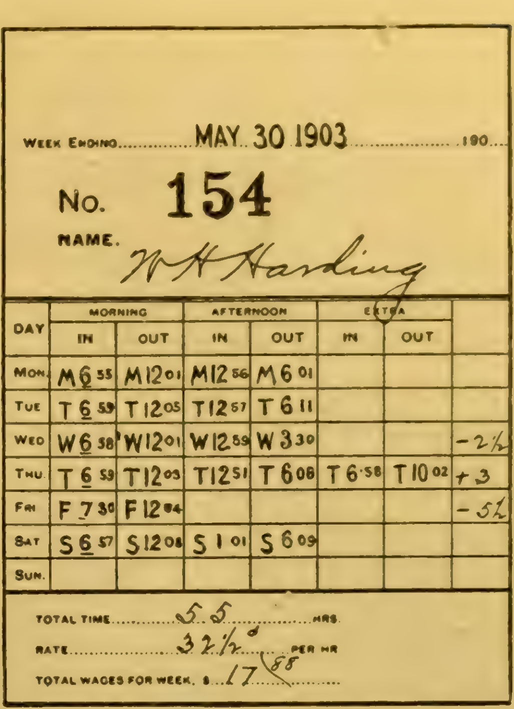
THE CALCULAGRAPH

week, so as to calculate his own time, if he so desires; and (3), the abandonment of the system of daily transfer of time to the individual payroll book or sheet with its liability of error and expense of transfer.

The recorder is placed in a central position on each floor of a factory or in each department, so as to be accessible to every employee without material loss of time in recording his time as he changes from one job or operation to another. The foreman performs the little clerical work required to fill out the cards when the employee begins the work. The workman has no clerical work to do; he simply registers his time when commencing and finishing the work called for on the card. The total time on these cost cards should equal his coming-and-going time recorded on his weekly time card for that day. If it does not, some explanation is expected from the foreman by the executive to whom the records are submitted. This card system of time recording is applicable to the work of the shipper, tool makers, sub-foremen, and cleaners, who may have single cost cards for an entire week. It may be arranged for piece work, premium plan, or day work. A device that gives not only the time of commencing and finishing but prints the elapsed time in hours and moments, as well as the time of day at either end of the period, is known as the Calculagraph. This appliance was originally brought out for use in timing the length of long-distance telephone calls. It has found a field, however, in the factory for cost-keeping purposes, a card being used for the record. The card is pushed into the slot of the device at the commencement of the job or operation, a lever operated, and then withdrawn until the completion

INTERNATIONAL TIME STAMP.

of the work when it is again inserted in the device and the other lever operated. The operation of the first lever prints the dials, which are connected with the arrows and revolved in chronological unison with the time-keeping mechanism of the clock. By operating the second lever the arrows only are printed. Dials and arrows being in chronological unison, the impression of each at separate times will show how far the combination has traveled in the interval between operations of levers (beginning and finishing of time period under measurement) or the elapsed time. Contrary to initial impressions of those looking into the merits of the device, it can be used by any number of employees.



WEEK ENDING MAY 30 1903 190

No. 154

NAME. W H Harding

DAY	MORNING		AFTERNOON		EXTRA		
	IN	OUT	IN	OUT	IN	OUT	
MON.	$M\,6^{55}$	$M\,12^{01}$	$M\,12^{56}$	$M\,6^{01}$			
TUE	$T\,6^{59}$	$T\,12^{05}$	$T\,12^{57}$	$T\,6^{11}$			
WED	$W\,6^{58}$	$W\,12^{01}$	$W\,12^{59}$	$W\,3^{30}$			−2½
THU.	$T\,6^{59}$	$T\,12^{03}$	$T\,12^{51}$	$T\,6^{08}$	$T\,6^{58}$	$T\,10^{02}$	+3
FRI	$F\,7^{30}$	$F\,12^{04}$					−5½
SAT	$S\,6^{57}$	$S\,12^{08}$	$S\,1^{01}$	$S\,6^{09}$			
SUN.							

TOTAL TIME 55 HRS.
RATE 32½^{c} PER HR
TOTAL WAGES FOR WEEK. \$ 17^{88}

FAC-SIMILE OF CARD USED IN THE INTERNATIONAL ROCHESTER RECORDER. ONE-HALF SIZE.

The use of time appliances for the dating of papers, signalling by programme clocks, and the recording of the movements of watchmen, are interesting applications but space forbids their description.

In a following number of this Magazine the author will discuss succeeding divisions of Appliances as given in outline on page 606. He will be glad to answer any inquiries.

A BIBLIOGRAPHY OF WORKS MANAGEMENT.

By Hugo Diemer.

With an Editorial Introduction, and an Index to the Current Literature of the Subject Prepared by the Editors of The Engineering Magazine.

WRITING in our Works Management Number (January, 1901), Mr. James N. Gunn spoke of "Industrial Engineering"—to use the broader term which he prefers—as "a science which only awaits the creation of a literature to have its own existence recognized as a new department of engineering." We are tempted to amend this dictum slightly by substituting "collation" for "creation." The creation of the literature has gone hand-in-hand with the development of the profession, and both have grown to meet the requirements of the evolution of manufacturing. It is the pride of The Engineering Magazine that it has been foremost in recognizing the new field of engineering enterprise, and in presenting to the profession some of the most important contributions to its literature.

We are glad, therefore, to present in the following pages what is probably the first systematic attempt to catalogue and review all the important works upon the subject, permanent and fugitive. The result is not supposed, by either author or editors, to be complete. As pioneers, we meet the difficulties of covering a field which is untraversed—indeed, not very certainly delimited. It is perhaps a reconnoissance rather than a survey. It will be enough if the work is sound, and provides a solid basis for further elaboration. The books are arranged generally in the order of their appearance, as this plan best displays the evolution of the science.

The author wishes us to say that the notes of the books by Charles Babbage, Sedley Taylor, N. P. Gilman, and Messrs. Sinclair and Frank Pearn, were editorially prepared, the works in question not being readily accessible to Mr. Diemer. We acknowledge further our obligations to our friends—especially to Mr. James N. Gunn—for the suggestion of authorities. The index to the current literature which follows Mr. Diemer's review of the more permanent works was prepared by the editors, most of the work of compilation being performed by Mr. J. H. Cuntz.—The Editors.

THE application of scientific methods to the investigation of problems of factory management has resulted in the accumulation of a bibliography of considerable extent having to do wholly with these questions. Fundamental pre-requisites or accompaniments to the study of such a bibliography are the three branches of learning in which he who would train himself for the profession of works management should be thoroughly grounded, namely, engineering, accounting, and economics. It is noteworthy that the authors of the works hereafter referred to have been, almost without exception, engineers, who have added to their technical training and experience the essential knowledge of accounting and of economics, requisite to a comprehensive grasp of the problems of factory management.

The ambitious engine tender has at hand several works of more or less merit on the steam engine. He is a subscriber to some technical or trade paper from which he gains advice and inspiration. The same is true of the first-class pattern maker and draftsman, and of any high-grade craftsman. The chief engineer and the master mechanic of a large industrial establishment usually have at hand a supply of high-class works of reference. It seems singular that the same should not be generally true of commercial managers, or of engineers who have been drawn into positions of works management. To be sure, the literature of factory economics is not abundant. Yet there have been some very good works published. A reading knowledge of some of these works would frequently be of great value to managers and their assistants in charge of departments. Such a knowledge might often result in the anticipation of plans and methods which would otherwise require years to mature. That this is true is evidenced by the frequent reproduction, in the most elementary form, of methods thought new and original by those introducing them, when in fact the same methods have been far more completely worked out by others. A similar ignorance of current practice and of best methods on the part of the mechanical and engineering staff, would be considered unpardonable.

A certain evidence of the lack of reading along these lines by those who might profit therefrom, is the ease with which an unscrupulous man who has made himself familiar with the literature of works management is able to palm off, as originated by himself, charts, tables and forms, and sometimes pages of discussion, copied verbatim from standard works. It certainly would be a profitable investment for many a manufacturing corporation to provide a reference library of such standard works as would be of particular application to and bear upon the business concerned, and to encourage the staff to make use of this reference library in and out of working hours.

In the following list of literature, there has been an intentional omission of such works as have been written on factory problems, the factory system, etc., by theoretic sociologists without practical experience, and also of works dealing generally with the science of economics in its political and sociological aspects, with but slight and incidental treatment of the economics of industry.

In reviewing the works, the endeavor has been made to find what particular feature has been the author's specialty. Naturally each writer, if he is a man of practical experience, will have made a special investigation of some particular branch. The emphasizing in the review of what this specialty appears to be, it is hoped, will assist in the selection of such papers or books as are particularly applicable to certain work in hand. The arrangement of the works briefly reviewed in this discussion will be chronological.

The earliest, and in many respects the most remarkable book relating to manufacturing problems is a small work written more than fifty years ago by the eminent engineer and mathematician, Charles Babbage. This work, which is now very rare, is entitled:—

1.—On the Economy of Machinery and Manufactures; by Charles Babbage, Esq. A. M.; London, Charles Knight; and Philadelphia, Carey and Lea, 1832. The latter is a reprint of the original English edition, and it is from this reprint, in the library of the American Society of Mechanical Engineers, that this notice has been prepared.

Mr. Babbage, in the course of his work upon his various forms of mechanical calculating machines, was impressed with the close relation of the use of machinery to various economic problems, and in this little book, of fewer than 300 duodecimo pages, he treats of questions, which, at the early date at which he wrote, were scarcely in existence, and which even now are rarely grasped with the clearness with which he discussed them.

After examining the sources of the advantages arising from the use of machinery in manufactures, together with the mechanical problems involved in the control, regulation, and application of power, he proceeds to discuss such subjects as the registering of operations, and the determination of the identity of work and its accuracy, in a way which might be studied to advantage to-day. Having obtained his information by the exercise of his keen powers of observation upon the occasions when he was permitted to examine factories then in operation, Mr. Babbage inserts an interesting chapter upon the method of observing manufactories, including a set of forms upon which inquiries might be made and replies noted, this forming an excellent indication of the thoroughness of his own researches. He then examines, quite in the modern mass-production method, the difference between making and manufacturing, following this study by comments upon the influence of verification and inspection upon costs, together with some hints as to the importance of considering the fluctuations of prices as measured by money in making comparisons between processes at different times. He proceeds to discuss the advantages of the division of labor, both physical and mental, and then examines the importance of determining the separate costs of each process in a manufacture, a subject which is even yet but imperfectly understood and still less perfectly practised.

There are chapters upon the reasons for the establishment of large factories, and some wise advice to those who may be considering the location of such establishments, together with a caution in regard to over-production, and hints upon the condition under which mechanical methods may properly be introduced. Although the book was written long before the present great combinations of labor organizations, or of trusts and employers' combinations, it contains chapters with the suggestive titles: "On Combination amongst Masters or Workmen against Each Other"; and "On Combination of Masters against the Public"; and these, and indeed nearly all the chapters of the little book, appear to have been written almost in a prophetic vein.

When it is considered that this work was written but a short time after the establishment of the factory system in England, and before railways had been commercially undertaken at all, it is a most remarkable production; and the fact that nothing more was produced upon the subject for more than fifty years indicates the extent to which the ideas of Babbage were in advance of those of his contemporaries.

The second work in the list, appearing long after Babbage, was:—

2.—Profit Sharing between Capital and Labour; Six Essays; by Sedley Taylor, M. A. To which is added a Memorandum on the Industrial Partnership at the Whitwood Collieries (1865-1874), by Archibald Briggs and Henry Currer Briggs. London, Kegan Paul, Trench & Co., 1884. Pp. xiii—170.

These essays give an account of the work of the French house-painter Leclaire, who, in 1842 started a co-operative system from which the present methods of profit sharing in France have developed. It also includes a description of the work of the society established in 1879 to promote the study of the system and to extend its use.

The essays include: Profit sharing in the Maison Leclaire, Profit Sharing in Industry, Profit Sharing in the Paris and Orleans Railway Company, Profit Sharing in Agriculture, and Profit Sharing in Distributive Enterprise; these all relating to applications in French industry. The Briggs memorandum describes the practical operation of the experiment in profit sharing at the Whitwood Colliery between 1865 and 1874.

3.—"The Depreciation of Factories, and Their Valuation"; by Ewing Matheson; published by E. & F. N. Spon in 1884.

This work is of great value in demonstrating the principles involved in the scientific handling of problems of inventorying and appraising. The book contains five chapters on "Depreciation" and eight chapters on "Valuation." It is written in an easy-flowing, clear style. A general discussion of depreciation, why and how it is used in accounting, is followed by division of the plant into various classes, and a discussion of the depreciation applicable to each class. Some examples follow, and also a very complete table showing the effects of depreciation at different rates for different periods of time—a valuable aid in appraisal work. Tables are also given showing the accumulation of a reserve fund with compound interest in a term of years, and how much must be invested annually as a sinking fund to accumulate a certain amount in a given terms of years. In regard to the matter of valuation, a full discussion is given of the many conditions which will affect valuations. The author discusses the valuation of a business as a whole, and of the factory buildings and plant. A new edition has lately been issued.

4.—"The Cost of Manufactures and the Administration of Work-Shops"; by Captain Henry Metcalfe, Ordnance Department, U. S. A.; published by John Wiley & Sons, the first edition having been printed in 1885.

This is an exhaustive and elaborate treatise on the order, stock-room, and cost-accounting methods employed in arsenal work. The author, at the close of the work, gives a list of such parts of the treatise as he considers general in their application. In an introductory chapter certain very sane and pertinent statements are made as to the art of administration, and its dependence upon the application of certain principles which make up what may be called the science of administration. In arguing that men intrusted with executive positions be freed from burdensome details, he says: "There is a certain economy of attention by which the more active a man's work, the less is he capable of contemplation. Foreman's heads may be put to better purposes than having to bear a constant burden of solicitude about clerical work."

The main body of the work is devoted to a description and criticism of old systems of arsenal accounting (which will be found even today to correspond to methods used in many shops), together with the results of the author's study in devising better methods of organization and accounting. The card system is used throughout, and the author illustrates every form used; filled in, in almost every case, as they would be in actual work.

An appendix, added to later editions, consists of a paper by the author on "The Shop-Order System of Accounts," delivered before the American Society of Mechanical Engineers, in May, 1886.

The most distinctive features of the work and of the appendix are a thorough discussion of the individual-operation order slip, or service card, which, together with the material card, form the basis of the cost-accounting system. The distribution of indirect expenses is not taken up very fully.

5.—"Factory Accounts"; by Emile Garcke and J. M. Fells; Crosby, Lockwood & Son, 1887.

In a preface the authors state that their aim has been to show that as great a degree of accuracy can be attained in factory book keeping as in commercial accounts.

The authors make a clear statement of the distinction between materials for manufacture and articles complete in the manufactured state. Until materials are converted into finished products of sale, they are spoken of as "Stores," but when so converted, they are termed "Stock." The accounts in the "Prime Cost Ledger" are debited with wages and materials spent in manufacture and are credited with the stock produced. Of 264 pages, 148 are devoted to descriptions of methods of accounting. The remainder of the volume consists of appendices, composed largely of British Factory and Work-Shop Acts.

The most meritorious part of the work is that which has to do with Stock and Stores accounting. The methods described for time keeping, pay-roll accounting, and piece-rate analysis so-called, have been much improved by later practice.

The authors show in complete detail a system of requisitions, purchase orders, and stores accounting records, by means of which double-entry balances may be kept on stores. The principles of the system are sound. A competent store keeper or purchasing agent should find no difficulty in adapting the ideas of the authors to the requirements of the particular business with which he is connected.

In the matter of cost accounting, the authors state:

> "It is not only important to know the cost of each individual article produced, but equally so to ascertain the cost of any particular part or of any particular process of manufacture. Localization of cost should be carried as far as possible, so that the varying rates of realizable profit on parts may be known, and the pressure to minimize cost of production be applied in the right direction."

The matter of labor costs and distribution of indirect expenses has not been worked out as fully as the stores problem. The double-entry balance principle is carried still further into a method of balancing the manufactured stock ledger acccounts with the commercial ledger. Charts built up of circles and arrows and tracing the relationships of forms and accounts, serve to simplify the schemes proposed, and to make clear the underlying principles.

6.—"Engineering Estimates, Costs and Accounts"; by A General Manager; Crosby, Lockwood & Sons, 1889.

This work is intended primarily as an aid to persons called upon to make estimates of costs of manufacture. There are some parts of the work that contain matter of considerable suggestive value to those having to do with running cost accounts. Several chapters are devoted to a discussion of methods of rapidly estimating quantities of material and time required for labor. A chapter on indirect expenses and their departmental distribution, although short, contains sound principles which may be applied to advantage in a further expansion of this important phase of manufacturing accounts. A great number of specific examples of estimates follow, covering almost every class of machine-shop and millwright work. The last chapter is devoted to costs' book keeping. Here again the best part of the discussion is that having to do with indirect expenses. A criticism of the methods described would be that there are too many bound volumes, many of which would be better replaced by loose-leaf or card systems. Again, dependence is made upon the workmen themselves for entries of labor, and upon records of store-room boys as to material consumed, without any check as to correctness of such draft at the time of issuing stores. The value of the book is in its discussion of the process and methods of estimating, rather than in any contribution to the science of cost keeping.

7.—"Gain Sharing"; a paper by Henry R. Towne; presented at the May 1889 meeting of the American Society of Mechanical Engineers.

This paper, and several others, will be listed among the books reviewed, since these papers well deserve the name of classics.

> "Webster defines profit as excess of value over cost, and gain as that which is obtained as an advantage. I have availed of this well-expressed though delicate distinction between the two terms, to coin a name for the system herein described, whereby to differentiate it from profit sharing as ordinarily understood and practiced. The right solution of this problem will manifestly consist in allotting to each member of the organization an interest in that portion of the profit fund which is or may be affected by his individual efforts or skill, and in protecting this interest against diminution resulting from the errors of others or other extraneous causes not under his control. Such a solution, while not simple, is attainable under many circumstances, and attainable by methods which experience has shown to be both practical and successful."

The plan advocated by Mr. Towne is the differentiating of all items affecting cost of production over which the operatives have any control whatever, and offering the operatives a share, say one-half, of any reduction per unit of product that they may be able to bring about in these items in the course of a year. Foremen and other responsible heads are to receive a larger pro rata share of the saving effected than the rank and file.

Mr. Towne presents tables showing the operation of the system for two years at the Yale and Towne Works. It is interesting to note that the company has discontinued the plan.

The discussion by Mr. E. F. C. Davis is the first record published of the so-called premium plan. He cites an instance of a friend of his who announced to his workmen that he would allow a definite number of hours to do a certain machine-shop job, and that of any time the workman saved over that, he would get one-half the benefit. Mr. Davis stated that after the workmen found that the offer was really made in good faith, the plan worked very well.

8.—Profit Sharing between Employer and Employee.—A study in the Evolution of the Wage System; by Nicholas Paine Gilman; New York and Boston; Houghton, Mifflin & Co., 1889. Pp. x-460.

A comprehensive review of the entire subject, discussing various forms of wage systems, followed by some account of the work of Leclaire in France and its extension on the Continent. There are chapters on profit sharing in transportation, distribution, and agriculture, together with historical and practical discussions of profit sharing in England and in the United States. A critical summary and analysis of experience in profit sharing is given, followed by a bibliography of the subject, including twenty-eight titles of books and pamphlets in English, French, and German, and references to articles upon the subject in periodicals. In "A Dividend to Labor. A Study of Employés' Welfare Institutions." (Houghton, Mifflin & Co., 1899; pp.

vi—400) the same author treats especially of welfare associations operated in connection with manufacturinng establishments, including clubs, libraries, relief departments, pension systems, etc. Some attention is also given to profit sharing, bringing the author's previous work down to date. There is a bibliography appended, extending down to 1899 the one given in the author's book on profit sharing.

9.—"The Premium Plan of Paying for Labor"; a paper by F. A. Halsey; presented at the June, 1891, meeting of the American Society of Mechanical Engineers.

Mr. Halsey briefly outlines the advantages and disadvantages of the day-work plan, the piece-work plan, and the profit-sharing plan, and then describes the premium plan as used by himself, citing specific instances illustrating the working of the method. "Under the day-work system, matters settle down to an easy-going pace, and the employer pays extravagantly for his product." With regard to piece work, Mr. Halsey discusses at length the evils of rate cutting. He presents as an objection to the piece-work plan an argument that may in many cases be a strong one in its favor, namely that it requires a knowledge and record of the cost of each piece of a complicated machine, and often-times of each operation on each piece, thus limiting its application to products which are produced in considerable quantities.

With regard to profit sharing, he objects that any system of profit distribution based on collective rather than individual efforts is unfair, that the remoteness of the reward is a disadvantage, that in bad business years there will be no distribution, and that the workmen have no check on the correctness of the employers' figures.

With regard to the premium system, he advocates varied hourly premium rates for time gained, depending on the character of the work, a detail that deserves more attention than it has generally received.

In the discussion, Mr. William Kent attests to the fact that Mr. Halsey spoke to him about the premium plan a year or so prior to Mr. Towne's discussion on gain sharing. Mr. Kent introduced the method at that time in the shops of the Springer Torsion Balance Company.

10.—"A Piece-Rate System"; by Fred W. Taylor; a paper presented at the June, 1895, meeting of the American Society of Mechanical Engineers.

In this paper, Mr. Taylor presents the first recorded recommendations in favor of a careful or scientific study of the subject of rate fixing, and of the differential piece rate. Piece-work prices based on elementary rate fixing differ from such prices as usually made, in that a careful study is made of the elemental times required to do each of the constituent steps into which the manufacturing operations of an establishment may be analyzed. These elementary operations are then classified, recorded, and indexed, and when a piece-work price is wanted for work, the job is first divided into its elementary operations, and the total time for the job is summed up from these elementary data.

The differential-rate system of piece work consists of the offering of two different rates for the same job—a high price per piece in case the work is finished in the shortest possible time, and in perfect condition, and a lower price per piece if it takes a longer time to do the job, or if there are any imperfections in the work.

Mr. Taylor expresses it as his opinion, based on extensive experience, that the workmen in nearly every trade can and will materially increase their present output per day, providing they are assured of a permanent larger return for their time than they have been receiving, and that employers can well afford to pay higher wages per piece, even permanently, provided each man and machine in the establishment turns out a proportionately larger amount of work.

The most formidable obstacle to the solution of the piece-work problem, Mr. Taylor states, is the lack of knowledge of the quickest time in which each piece of work can be done, the remedy for this lying in the establishment in every factory of a proper rate-fixing department.

In closing the discussion of his paper, Mr. Taylor expressed regret that the elementary rate-fixing features of the system he described did not receive more attention by the members discussing his paper, and stated it as his firm conviction that this question must occupy more and more of the attention of manufacturers in the future.

This paper of Mr. Taylor's, together with his later and exhaustive one delivered at the June, 1903, meeting (an abstract of which is given in this bibliography), deserve the most careful perusal of every manufacturer. The author's statements regarding elementary rate fixing are enunciations of broad general principles which, no doubt, have been applied by other successful managers, and it is only narrow mindedness that will prevent careful study of his papers on the ground that they have been a source of profit to the gentlemen exploiting so-called "systems" based on these same broad principles of industrial management.

11.—"The Commercial Organization of Factories"; by J. Slater Lewis; E. & F. N. Spon, 1896.

Mr. Lewis's comprehensive work of 540 7 by 10 pages, deals with administration, organization, and accounting. The fact that a specific system is traced through the work with elaboration of its minutest details, makes the work one that requires the closest sort of application and study in order that one may get from it the principles generally applicable. Much attention is devoted to strictly commercial office accounting.

To Mr. Lewis belongs the credit of making a very full exposition of the important subject of the proper distribution of establishment charges, as he calls them, or expense accounts as generally designated in America. Chapter XXIII of the work devotes seventeen pages to a thorough treatment of this subject, which is carried out even more fully in Chapter XXXIV, on "Works and Job Office," in which the "Standing Order" system is also explained.

Mr. Lewis makes use of the chart method of circles and arrows as previously employed by Garcke and Fells, in illustrating the connection between the accounts and forms illustrated. He also carries the chart system a step further to illustrate the staff organization of the factory.

12.—"The Commercial Management of Engineering Works"; by Francis G. Burton; The Scientific Publishing Co., Manchester, 1898.

As the author states in his preface, this work is intended primarily for young engineers. Its object is to present to these young men the problems that are likely to confront them, when commercial duties are thrust upon them, and to offer suggestions that may be of assistance. The work does not claim to represent the results of any scientific research in any special field of factory organization or administration. "Engineering Estimates and Cost Accounts" is an earlier book by the same author.

13.—"The Management of Engineering Work Shops"; by Arthur H. Barker; The Technical Publishing Co., Limited, Manchester, 1899.

Mr. Barker's book bears throughout the impress of the practical shop man. It is free from pedantry, original in expression, and independent in attitude. It is not so much a book of detailed commercial accounting forms as a collection of principles and experiences. Of 208 pages, 140 are devoted to topics dealing with factory arrangement, equipment, and administration. The remaining 68 pages are devoted to the subject of costs. The portions of the work devoted to the drawing office, and the tool equipment of the shops, are practical and detailed. The system of drawing-office control of all orders is advocated throughout.

> "There must be a definite routine in the issuing of all orders, and the meaning of them must be perfectly clear. The workman, be he draftsman, clerk, or mechanic, who knows exactly what he has to do, will do the work in half the time that he will occupy if he has first to find out what is wanted. This principle cannot be too strongly insisted on. It is impossible for anyone to work vigorously if he has only a hazy conception of what he has to do. Loosely worded or incomplete instructions are responsible for a greater waste of money than anything else, without exception."

The classification of establishment costs is also thoroughly treated.

> "The subject of establishment costs naturally divides itself into two parts, (1) the reckoning up and classifying of the amount actually spent in keeping up the establishment during each year, (2) the division of this total amount among the various orders executed in the shop. If it were possible to wait till the end of the year before making this division, the problem would be very much simplified. In practice, however, the final cost of the article has to be got at within a very short time of the completion of the order. To keep the establishment accounts correctly is a highly complex piece of book keeping. The cost-keeper to be really efficient must be not only a trained engineer, but must have a very thorough knowledge of book keeping, and these two qualifications are very rarely combined. The objection of many firms to the proper distribution of establishment costs is the more surprising because it can be done" (if undertaken by competent men) "with very little extra trouble. It is merely a question of the page or column in which certain items are entered. It seems obvious that it is impossible to check the extravagances of any department unless the accounts of that particular department are kept separate from those of other departments."

14.—"The Complete Cost-Keeper"; by H. L. Arnold; published by The Engineering Magazine Co., 1900.

This work, with which almost every American engineer who has had to do with factory costs is familiar, is an outgrowth and development of Mr. Arnold's contributions to THE ENGINEERING MAGAZINE between the year 1895 and the date of publication of the work. These papers, which were contributed under the *nom de plume* of "Henry Roland," had attracted wide attention. The book presents various cost-keeping systems in actual use, varying in complexity. Every blank is given in full and has its actual sizes specified. A description is included of all mechanical aids to factory accounting, including time-clocks, recording clock stamps, computing machines, etc. Among the manufacturers whose systems are described, are Strieby & Foote, drop forgings, Newark, N. J.; The Hyatt Roller Bearing Co., Newark, N. J.; The DeLaval Separator Co., Poughkeepsie, N. Y.; Struthers, Wells & Co., Warren, Pa., steam and gas engines, boilers, etc.;

The National Switch & Signal Co., Easton, N. Y., and that of a prominent American electrical works, whose name is withheld, the last named being supplied by James N. Gunn.

15.—"Cost Accounts of an Engineer and Iron Founder"; by J. W. Best; a paper read before the Sheffield Chartered Accountants' Students' Society, December 12, 1900. London, Gee & Co.

Mr. Best's work is strictly confined to accounting. He believes that all cost accounts should be made to dovetail into the regular commercial accounting system. He begins with the final "Trading Account" into which have been entered the summarized results of the cost accounts. By working backwards he shows, step by step, how these accounts may be made to give just as much satisfaction as to balances as any of the ordinary double-entry accounts handled by a book keeper. Mr. Best illustrates each step by an actual form filled out, as used in foundry work.

16.—Cost Accounts; by C. A. Millener; The Hunter Rose Co., Ltd., Toronto, 1901.

Mr. Millener considers the subject of factory costs from the standpoint of the accountant rather than of the manager. Like most British writers on the subject, he works out a scheme which makes all the departmental and cost accounts part of the general double-entry book keeping of a corporation. His method of presentation is particularly clear, and the small folio of 60 pages is full of valuable suggestive matter, particularly as it deals with industries other than machine shops.

Mr. Millener recommends the monthly balancing of the final "Trading Account." He deprecates the practice of using estimated values of stock for inventory purposes, claiming that an inventory should give the exact actual cost of articles. If the goods would not realize their cost, the depreciation in value should be made good by a charge in "Trading" account and a credit to "Depreciation in Goods" account. In regard to what should be considered profits, he says "A true profit is only one that is actually realized by means of a sale." "An ample percentage on the volume of sales should be charged each year against Profit and Loss and credited to Bad Accounts, and a reserve gradually formed in excess of the usual yearly requirements, to cover all accounts finally abandoned as bad."

Sample accounts are given illustrating the accounting system as applied to a cement works, a flour mill, a sash and door factory, a clay works, and a coal-mining and iron-founding business.

17.—"A Bonus System of Rewarding Labor"; a paper by H. L.

Gantt; presented at the December, 1901 meeting of the American Society of Mechanical Engineers.

The paper is a description of a system introduced by the author into the machine-shop of the Bethlehem Steel Co. An instruction card is made out, showing in detail the best method (so far as knowledge and experience available can give it), of performing each of the elementary operations on any piece of work, specifiying the tools to be used, and setting the time needed for each of these operations as determined by experiments. The sum of these times is the total time needed to complete the piece of work. If the workman accomplishes all the work assigned in any one day within the total time limits specified, he is paid a definite fixed bonus, in addition to the day rate which he always gets. If he fails, he gets simply his day rate. As the time for each detail operation is specified on the instruction card, the workman can see continually whether he is going to earn his bonus or not. If he finds any operation which cannot be done in the time specified, he must at once report it to his foreman. If, on careful investigation by the man making out the card, the workman's statement is found to be correct, a new instruction card is made out, explaining the proper method of working, and allowing the proper time.

The foremen also receive, in addition to their day wages, compensation proportional to the number of their men who earn a bonus, and an extra compensation if all of their men earn bonuses.

> "As the instruction cards are made out by a skilful man with the records at hand, they invariably prescribe a better method for doing the work than the ordinary workman or foreman could devise on the spur of the moment. . . .
>
> "The system has many of the advantages of the differential piecework method, by which the compensation is quite large for the maximum amount of work obtainable. Since it is impossible for men to earn bonuses when their machines are out of order, an automatic punishment is provided for breakdowns. . . .
>
> "Considerable training is necessary to teach the men, who as a rule are ordinary laborers, to follow the instruction cards. Having once given them this training, however, the advantage of having a first-class machinist to do the thinking and to use for them the best results already obtained, produces an efficiency which would be absolutely impossible if the workmen were left to themselves."

Samples of the forms used are given, as filled out in actual use. The author states:

> "If we have a thorough knowledge of all the conditions, and are able to introduce piece work, it is undoubtedly to be preferred. But we must remember that aside from the great injustice of it, there is nothing so demoralizing as cutting piece rates."

The bonus system carries with it the advantage that if the time allowance is too easily reached, a limit is nevertheless set to any workman's daily gain, which can never be more than the fixed daily bonus.

18.—"The Cost of Production"; by Charles J. Watts; The Shaw-Walker Co., Muskegon, Michigan, 1902.

Mr. Watts' little work shows the application of the card system to all phases of cost-department accounting. In the method employed by him, the shop-department clerks do the direct entering of departmental details, separate card forms being used to cover departmental material, direct labor, and indirect labor. These cards are summarized by a central cost department. The card system is also used in localizing the general expense accounts, and in keeping a perpetual inventory. The style is concise and clear, and while the particular examples shown are from the agricultural-implement business, they are quite general in their application.

19.—"Cost-Keeper's Wage Schedule"; by G. Albert Lang; published by the author, St. Louis, Mo., 1902.

A table in book form, showing the earnings by 5-minute intervals, for all weekly wages between $2 and $25, by 25-cent intervals. The results are based on a 10-hour day. The book is indexed by tabs for the weekly wage.

20.—"Shop Management"; by Fred Taylor; a paper presented at the June, 1903, meeting of the American Society of Mechanical Engineers.

This exhaustive paper, which covers 150 pages of the Society's Transactions, is a record of some twenty years of genuine research work by the author. The compiler of this bibliography emphatically agrees with Mr. Henry R. Towne in his characterization of this paper as the most valuable contribution to this subject which has yet been made. As stated by Mr. Towne, it includes so complete a review as to constitute almost a history. It is clear-cut and comprehensive, written in a characteristic, vigorous, clear style.

Mr. Taylor brings out again, and in greater detail than in his former paper of 1895, the importance of scientific time study as the foundation of the best management. In addition to the more detailed description of scientific rate fixing, the other new features not brought out in his previous paper referred to are the use of the "Instruction Card" to accompany any system of compensation, whether it be Mr. Gantt's bonus, Mr. Taylor's differential piece rate, the premium method, or ordinary piece rate; also the system of functional foremanship.

Functional management consists in so dividing the work of management that each man, from the assistant superintendent down, shall have as few functions as possible to perform. If practicable, the work of each man in the management should be confined to the performance of a single leading function. As examples of this functional management, there are suggested, in the factory office, the man in charge of order of work or routing department, the one in charge of instruction-card department, the time and cost clerk, and the shop disciplinarian, these four divisions making up what Mr. Taylor calls the "planning department." In the shop itself the functional foremanships are those of "gang boss," who has charge of the preparation of all work up to the time the piece is set in the machine, including the selection and providing of jigs, templets, drawings, etc.; the "speed boss," who must see that the proper cutting tools are used, that the cuts are started right, and that the best speeds and feeds are employed; the inspector, who is responsible for the quality of the work; and the "repair boss," who sees that each machine is kept clean by its operator and free from rust and scratches, and that it is oiled and otherwise properly treated.

While the complete scheme as outlined by Mr. Taylor is applicable in all its details only to large works, the principles emphasized are capable of application in moderate-sized shops.

21.—"The Factory Manager and Accountant"; by Horace L. Arnold; 1903. The Engineering Magazine Co., New York. Mr. Arnold's second work, like his first, is a presentation of working systems as employed by prominent American manufacturing corporations. Mr. Arnold does not spend any time in theorizing or arguing. He presents the system to the reader, who can judge for himself whether the conditions in his case are similar to one or the other of the examples given. To use the author's own words:

> "As the able manager looks over his own particular industrial kingdom, small or large, in the new light of defining and recording inevitabilities, and considers the means by which he shall place and direct his assistants, and record their acts, and shall also place and record the movements of every piece and thing inside the factory walls, he is appalled by the endless series of record-forms needed, and the endless labor of writing the records. Hence the practicable solution of the problem is to be found most surely through studying exactly what others have done with success."

Among the corporations whose systems are described, are the Link-Belt Engineering Co., the Bigelow Co., New Haven, Conn., the C. B. Cottrell & Sons Co., Westerly, R. I., the Potter & Johnston Machine Co., Pawtucket, R. I., The Wells Bros. Co., Greenfield, Mass. and the C. W. Hunt Co., West New Brighton, N. Y.

22.—"Manufacturers' Accounts"; by W. C. Eddis and W. B. Tindall; published by the authors, Toronto, 1904.

The general scheme of accounting is identical with that used by Mr. Best in his "Cost Accounts of an Engineer and Iron Founder." The general results of the business are shown in a "Trading Account" to be balanced at frequent intervals. Going backward from this the component accounts and entries are illustrated, the idea being to apply the ordinary methods of commercial double-entry accounting books to all phases of cost accounting. The particularly distinctive feature of the work is that designated at Part II, which gives specific examples of the system as applied, first to an engine and boiler manufactory, second, to a candy-manufacturing establishment, and third, to a lumber establishment. A third part is composed of forms of general commercial books to be used in connection with the cost-accounting methods advocated.

23.—Workshop Costs for Engineers and Manufacturers; by Sinclair Pearn and Frank Pearn; 21s, net; size 18 by 10, 34 pages and 42 full-size rulings and specimen entries; 1904.

Describes the system worked out by the writers as managing directors of the well-known Manchester Pumping Machinery works, with special reference to costs of machines of which the parts are standardized. A very important book, owing to the practical nature of the information and the excellent working examples and forms given. No attempt is made to deal with establishment charges, but as a prime-cost system and organization the method described should be studied by all interested in factory accounting.

INDEX TO THE PERIODICAL LITERATURE OF INDUSTRIAL ENGINEERING.

Editorially Compiled.

PRIOR to the establishment of The Engineering Index, which now forms a department in every issue of THE ENGINEERING MAGAZINE, no effective attempt had been made to catalogue the contents of the technical press. There was no method, except the impossible one of exhaustive reading, by which the specialist could learn what was being published in his own particular subject, to say nothing of keeping himself informed as to the general progress of cognate branches. Twenty-one years ago, the late Prof. J. B. Johnson began the systematic indexing of current engineering journals, with the additional characteristic idea of embodying in each index reference a concise descriptive note, sufficient to define, to the consultant of the work, the scope and character of each article, and thus to save him the labor of looking up such as were not useful to his purpose.

As taken up and expanded by this Magazine, the work has grown to a range and to dimensions far exceeding any contemplated by its founder. As it appears monthly in THE ENGINEERING MAGAZINE, it is a classified summary of all the current technical literature—American, English, or Continental—interesting to engineers. As it is republished from time to time in volume form, it is an exhaustive reference index to the technical press of the period it covers.

The following special index to articles on all phases of industrial engineering, like the preceding bibliography of the more permanent contributions to the subject, is a pioneer work in the selection and compilation of the entire body of its literature. It is based on Volumes I, II, and III of THE ENGINEERING INDEX and on the monthly index in THE ENGINEERING MAGAZINE since the date of the last volume (1900). The arrangement under the classified headings is chronological, with the idea of making this index a display of the historical development of the science of works management. It is of interest to note that hardly a single reference was found in Volume I, and few in Volume II. From that time on the number increases in rapid progression. Those who are closely interested in the subject may find in this index a fairly complete reference list up to the present time, which may be kept up to date by the use of THE ENGINEERING INDEX as it appears monthly in this Magazine.—THE EDITORS.

AN INDEX TO THE LITERATURE OF INDUSTRIAL ENGINEERING.

APPRENTICESHIP.

*Education for the Workshop. Frederic A. C. Perrine. A discussion of the best means of giving young mechanics a higher training, particularly in night schools. 3000 w. The Engineering Magazine—May, 1892.

Presidential Address of Mr. Archibald Denny. Delivered before the Inst. of Junior Engineers, upon the apprentice system, and the handling of young men in the drawing office, the workshop and in business positions. 5500 w. Engineer, London —Nov. 15, 1895.

Apprenticeship. Editorial on an article in the *London Technical Education Gazette* which was a summary of results of a systematic inquiry into the state of apprenticeship in the various trades of London, and views of various employers regarding the possibility of developing the system in the future. The article deals only with the building trades. 2800 w. Builder—Nov. 16, 1895.

The Apprenticeship System under Modern Conditions. System employed in the shops of the Brown & Sharpe Company. 800 w. Scientific American—July 4, 1896.

The Training of Apprentices. The system in use in the French railway workships, where the apprentice is educated in theory, simultaneously with his manual training. 1100 w. Engineering—July 17, 1896.

Status of Apprenticeship in the Trades Concerned in the Production of Machinery. Letters from 116 of the most prominent machinery building establishments and important railway systems of the country, stating their practice and views regarding apprenticeship. 24,000 w. American Machinist—Dec. 24, 1896.

The Improvement of the Apprenticeship System as a School for Mechanics. Discussion of the relation of employer and apprentice and the means of making this system of value, with reasons. 2800 w. Engineering News—March 4, 1897.

An Apprenticeship System in College Shops. O. P. Hood. Read at the Columbus meeting of the Society for the Promotion of Engineering Education. Explains the opinions that led to a trial of an apprentice system, the results, and the writer's belief in its usefulness. 1600 w. American Machinist—Aug. 24, 1899.

Mechanics, Their Relation to Each Other and to Mechanical Industries—Trade Schools. John E. Sweet. Excerpts from an address delivered at Rochester, N. Y., on the apprenticeship feature of the mechanical industries and trade schools. 3700 w. American Machinist—Sept. 7, 1899.

Modern Apprenticeship Conditions. John E. Sweet. From an address before the manufacturers and mechanics of Rochester, N. Y. Considers the training of the schools and of the shops, and the duties of employers and employees. 4500 w. Iron Trade Review—Jan. 18, 1900.

The Problem of the Molder. John G. Sadlier. The slow advancement in foundry practice, and the importance of selecting the right apprentices and educating them. 1800 w. Journal American Foundrymen's Ass'n—June, 1901.

A Systematc Plan of Apprenticeship. Describes the plan at the Baldwin Locomotive Works, with editorial comment. 2000 w. American Engineer & Railroad Journal—Oct., 1901.

The Technical Education of Railway Apprentices in France. A description of the educational system afforded by apprenticeship classes of the Chemins de Fer de l'Est. 4800 w. Engineer, London—Jan. 24, 1902.

What Can Our Schools Do for Foundry Apprentices? P. Kreuzpointner. Discusses school training and what should be demanded of apprentices. 4800 w. Journal American Foundrymen's Association—Feb., 1902.

* The Present Industrial Importance of Technical Education. Sir Philip Magnus. A review of the relation of technical education to commercial supremacy, with reference to the foresight of Germany as compared with Great Britain. 4000 w. The Engineering Magazine—Nov., 1902.

Apprenticeship in Engineering Training. John Dewar Cormack. Read before the Engng. Con. of the Inst. of Civ. Engrs. The discussion is confined to the training of youths destined for responsible positions, as employers, manufacturers, consulting engineers, etc. Also general discussion. 8000 w. Engineering—June 26, 1903.

The Apprenticeship System at Brown & Sharpe's. William A. Viall. Read at meeting of Nat. Mach. Tool Bldrs. Assn. 1800 w. Iron Age—July 2, 1903.

College or Apprenticeship. Louis H. Ransome. A consideration of the two systems of training, with a view to seeing in what direction improvements should be sought. 2000 w. Engineer, London—Aug. 21, 1903.

Apprenticeship in Engineering Training. John Dewar Cormack. A discussion of the best training and the conditions that should be fulfilled. 1800 w. Railroad Gazette—Sept. 11, 1903.

Engineering Apprentices. D. B. Morison. Outlines a scheme for the advancement of apprentices to be given a trial at the Hartlepool Engine Works. Also editorial. 2400 w. Engineering—Sept. 25, 1903.

Apprenticeship. Robert Patterson. A paper read before the Canadian Railway Club, describing the system of training apprentices at the shops of the Grand Trunk Railway. 2500 w. Railroad Gazette—Oct. 2, 1903.

The Apprenticeship Question. John E. Sweet. Read before the Mutual Trades Assn. of Syracuse, N. Y. Remarks on the changed conditions and the necessity of providing proper instruction for American boys who wish to become mechanics, suggesting ways. 2800 w. American Machinist—Oct. 22, 1903.

* The Training of Apprentices in Engineering Works. C. E. Downton. A description of the system and methods of training apprentices in the works of the Westinghouse Electric and Manufacturing Co. 3500 w. The Engineering Magazine—Dec., 1903.

The Money Value of Technical Training. James M. Dodge. President's address at meeting of the Am. Soc. of Mech. Engrs. Also editorial. 5000 w. Engineering Record—Dec. 5, 1903.

*An Example of the Modern Development of the Apprenticeship System. L. D. Burlingame. Describing the sysytem in successful operation in the shops of the Brown & Sharpe Mfg. Co., at Providence. 3500 w. The Engineering Magazine—Jan., 1904.

* The Mechanic of the Future and His Training. E. P. Watson. A comparison of the modern manual-training methods with the older apprenticeship system, showing the necessity for experience in the commercial shop. 4000 w. The Engineering Magazine—Feb., 1904.

The Technical Graduate and the Machinery Department of Railroads. W. F. M. Goss. Outlines the development of the technical graduate, his training, etc., and considers some of the defects in the administration of special apprenticeship, and the remedy. General discussion. 12,500 w. Proc Western Railway Club—March 15, 1904.

* Apprenticeship Systems of the Allis-Chalmers Company. P. W. Gates. A practical system, ad-

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Throughout this index, the asterisk (*) prefixed to the title of an article indicates that it appeared originally in The Engineering Magazine.

justable to widely diversified conditions. 2000 w. The Engineering Magazine—April, 1904.

* What Manchester is Doing for Engineering Apprentices. F. Brocklehurst. An account of the great electrical and mechanical trade school at Manchester. 3000 w. The Engineering Magazine—May, 1904.

* The System of Apprenticeship at the Baldwin Locomotive Works. S. M. Vauclain. Description, with illustrations and diagrams, of the three classes of apprentices, and other features of a system which has long been in use with most successful and fortunate results. 2000 w. The Engineering Magazine—June, 1904.

COST-KEEPING.

Cost in Manufactures. Henry Metcalf. A lecture at Cornell University on methods of obtaining costs. Scientific American Sup—Aug. 6, 1887.

Methods of Ascertaining the Cost of Manufactures. Prof. C. H. Benjamin. Paper before the Civil Engineers' Club of Cleveland. Abstract, with record forms, etc. Journal Ass'n of Engineering Societies—March, 1891.

Some Uses of Cross-Section Paper in the Machine Shop. William O. Webber. Its use in keeping the run of shop expenses and estimating cost of jobs. 1100 w. American Machinist—Nov. 21, 1895.

The Use of Graphical Methods in Keeping the Accounts of Railway Mechanical Departments. An advocacy of the system, with illustration taken from a western road. 900 w. American Engineer & Railroad Journal—June, 1896.

Cost-Keeping—Some Large Air Hoists—A Right-Angle Coupling—A Rack Cutter—The Centers of Arbors. S. T. Freeland. Brief consideration of subjects named. 2600 w. American Machinist—Nov. 12, 1896.

A Method of Determining Selling Price. H. M. Lane. Tells how conditions determining the yearly balance sheet may be shown at the end of each month or week. 1700 w. Trans. American Society of Mechanical Engineers—Dec., 1896.

Valuation of Manufactures. Oberlin Smith. Discussion of appraisers' work; advocates valuations too low rather than too high. 3300 w. American Machinist—Dec. 17, 1896.

*Mine Accounts. J. Parke Channing. Analyzing the expenses of mine operation and suggesting a method of recording them. 3700 w. The Engineering Magazine—Sept., 1897.

*Cost-Keeping Methods in Machine Shop and Foundry. Henry Roland (H. L. Arnold). A series of four articles. The Engineering Magazine—Oct., Nov. and Dec., 1897, and Jan., 1898.

No. 1. Elements, and influence of wage systems. 3700 w.

No. 2. Details of several large shops compared, especially piece-work systems. 6000 w.

No. 3. Methods of leading shops for checking piece production. 4000 w.

No. 4. General expense and selling price. 3500 w.

An Electrical Time-Recording System. A method of automatically operating a number of subsidiary clocks from a master timepiece. Ill. 1000 w. Practical Engineer—Oct. 8, 1897.

Diagram Accounts for Engineering Works. John Jameson. Paper before the Institution of Mechanical Engineers. 2800 w. Engineering—Nov. 12, 1897.

Time Saving and Its Relation to Profits. Henry Hess. Analysis of methods for reducing costs, with examples and diagrams. 4200 w. American Machinist—Dec. 16, 1897.

Method of Keeping Weekly Shop Costs. W. N. Moore. A method which has proved effective after several years' experience. 1300 w. Railway & Engineering Review—Dec. 18, 1897.

The Bundy Time Recorder. Illustrated detailed description. 1300 w. Engineer, London—March 11, 1898.

Cost-Keeping and Accounting. W. S. Rogers. Paper and discussion before the N. Y. Railroad Club. 7500 w. N. Y. Railroad Club—Sept. 15, 1898.

The Card-Index System of Cost-Keeping. Illustrated description of methods used by the Bullard Machine Tool Co., of Bridgeport, Conn. 2500 w. American Machinist—Sept. 15, 1898.

*Effective Systems of Finding and Keeping Shop Costs. Henry Roland (H. L. Arnold). A series of eight articles. The Engineering Magazine—April-Nov., 1898.

No. 1. An exposition of the "job-ticket" system. 3500 w.

No. 2. The collective job-ticket system as applied in a drop-forging works. 3500 w.

No. 3. Methods in use at machine tool works of Bement, Miles & Co., Philadelphia. 3000 w.

No. 4. Newton Machine Tool Works, Philadelphia. 3500 w.

No. 5. Hyatt Roller Bearing Co. 4000 w.

No. 6. Sprague Electric Co. 4500 w.

No. 7. Minutely-divided accounts of a signal-manufacturing company. 5000 w.

No. 8. Methods of determining and apportioning the expense account, including the relations of productive labor to general expense. 8500 w.

*A Simple and Effective System of Shop Cost-Keeping. H. M. Norris. Gauging the cost of work in process of manufacture, with many blank forms. 4500 w. The Engineering Magazine—Dec., 1898.

A Colliery Cost Sheet. G. Johnson. Illustrations of bank and underground pay-bills. 1100 w. Colliery Guardian—March 3, 1899.

Shop and General Establishment Charges in Engineering Works and Their Relation to Costs and Estimates. Wm. Edward Cowens. Paper before the Northeast Coast Inst. of Engineers and Shipbuilders, written from the works manager's standpoint. 2800 w. Ind & Iron—May 5, 1899.

The Balance Sheet of a Mining and Manufacturing Company. George Johnson. Describes in some detail the various assets and liabilities. Serial. 1st part. 3800 w. Iron & Coal Trades Review—Sept. 1, 1899.

An Automatic Cost Distributing and Accounting Plan. W. S. Rogers. Describes plan as worked out and applied. 3000 w. Iron & Coal Trades Review—Nov. 10, 1899.

Uniform Accounting for Gas and Electric Lighting Companies. James Blake Cahoon. Abstract of paper at Chicago meeting of Nat'l Electric Light Assn., and editorial on "Uniform Accounting a Prerequisite to National Municipal Statistics." 3000 w. Engineering News—June 14, 1900.

Cost-Keeping at the Chicago Works of Fraser & Chalmers. Describes a system that has been in satisfactory operation for four years. Serial. 1st part. 2200 w. American Machinist—Nov. 1, 1900.

*The Expense Account of the Machine Shop. Horace L. Arnold. A discussion of an important element in cost-keeping, showing the true method of treating indirect factory expenditures. 3500 w. The Engineering Magazine—Dec., 1900.

*Cost-Keeping: A Subject of Fundamental Importance. J. N. Gunn. A discussion of the fundamental principles essential to the establishment of a satisfactory system. 3000 w. The Engineering Magazine—Jan., 1901.

The Principles of Cost Accounting. F. A. Halsey. Lecture before the mechanical engineering students of Cornell Univ. Discusses the objects of cost accounting, the principles involved, methods, etc. 8000 w. Sibley Journal of Engineering—April, 1901. Also in American Machinist—June 20 and 27, 1901.

Mine Account Keeping and the Monthly Statement of Costs, as Adapted to the Business of Metalliferous Mining. Charles V. Jenkins. Describes a thorough system. 10300 w. Mines & Minerals—Aug., 1901.

*The Proper Distribution of the Factory Expense Burden. A. Hamilton Church. A series of six papers. The Engineering Magazine—July to Dec., 1901.

No. 1. The interlocking of general expense with price costs. 3500 w.

No. 2. Camparison of the various methods of apportioning expense to work, depending on the character of the work. 4000 w.

No. 3. The scientific machine rate and the supplementary rate, with development of an accurate system. 3300 w.

No. 4. The classification and dissection of shop charges. 4500 w.

No. 5. Factory and mass production, and the new machine rate. 3500 w.

No. 6. The proper apportionment of office and selling expense, and general summary of the whole series of papers. 4000 w.

*Aids in Taking the Machine-Shop Inventory. Hugo Diemer. Discussing a simple method of employing the card index and showing its advantages for inventory purposes. 2500 w. The Engineering Magazine—Feb., 1902.

Analyzing Cost of Machinery Making. Oberlin Smith. 2800 w. Iron Trade Review—April 3, 1902.

Workshop Records in Cards and Files. George Parker. Read before the Northeast Coast Inst. of Engineers & Shipbuilders (Great Britain). Describes applications of cards for various purposes, and gives the origin of the system. 7700 w. Iron Trade Review—May 1, 1902.

Cost-Keeping and Wage System of the Stilwell-Bierce & Smith-Vaile Co. Descriptive articles outlining the system of the purchasing department. 2300 w. Iron Trade Review—June 5, 1902.

Co-Operative and Mechanical Aids to Workshop Cost-Keeping. R. P. Link. Read before the Inst. in Sunderland. Calls attention to the method of utilizing automatic machines to control the keeping of costs in shops. Also discussion. 4800 w. Trans. of N. E. Coast Inst. of Engineers & Shipbuilders—July, 1902. Also in Mechanical Engineer of April 26, 1902.

Workshop Records. A Review and Comparison of Existing Methods, with Special Reference to the Use of Cards and Files Instead of Books. George Parker. Read before the meeting in South Shields. Also discussion and 2 plates. 13400 w. Trans. of N. E. Coast Inst. of Engineers & Shipbuilders—July, 1902.

Shop-Record System of the Pearson Machine Company. Describes methods in use in a shop which manufactures turret lathes, screw machines, forming and drilling machines, and horizontal boring machinery. 1300 w. Iron Trade Review—July 3, 1902.

A New Factory Cost-Accounting System. Wilfred Bancroft. Describes a method devised to furnish the fullest possible information about every operation, on every piece, in a machine containing some 1,500 pieces. 3800 w. American Machinist—July 24, 1902.

The Electrical Tabulating Machine Applied to Cost Accounting. An illustrated article explaining the method of utilizing this machine in manufacturing establishments. 2000 w. American Machinist—July 31, 1902.

Cataloging Small Machine Parts. L. P. Alford. Describes a system used in cataloging and arranging the data regarding the small parts of about 150 machines. 2000 w. American Machinist—Sept. 25, 1902.

*Cost-Finding Methods for Moderate-Sized Shops. H. L. Arnold. The methods of the Bigelow Company, of New Haven, Conn., employing about 200 men in the manufacture of steam boilers. 3000 w. The Engineering Magazine—Dec., 1902.

*Cost-Finding Methods for Moderate-Sized Shops. A Successful Example Under the Premium Wage System. Hugo Diemer. A description of the methods of the Cincinnati Milling Machine Co. 2500 w The Engineering Magazine—Jan., 1903.

The "Duca" Card System. Robert Grimshaw. Gives card forms used by a German machinery manufacturer for keeping an account of office and shop items, with explanatory notes. 1900 w. Iron Trade Review—Jan. 1, 1903.

*Cost-Finding Methods for Moderate-Sized Shops. H. L. Arnold. A description of the system in practical use at the Cottrell printing-press works, Westerly, R. I. 3500 w. The Engineering Magazine—Feb., 1903.

*Cost-Finding Methods for Moderate-Sized Shops. William Magrutor. A description of the system of the Southern Engine and Boiler Works, employing about 300 men on engines, boilers, and saw-mill machinery. 2500 w. The Engineering Magazine—March, 1903.

Comparative Statements. Henry W. Brooks, Jr. On the importance of intelligent accounting, and the value of comparative statements showing the results of any change in policy or methods. Refers chiefly to street railway work. 2500 w. Street Railway Review—March 20, 1903.

*Cost-Finding Methods for Moderate-Sized Shops. Kenneth Falconer. A general account of the system used by the Canadian Company, engaged in the manufacture of type-composing machines; giving details and forms used. 2500 w. The Engineering Magazine—April, 1903.

*The General Principles of Mine Accounting. E. Jacobs. A comparison of the engineering methods of mining with the corresponding business principles applicable to the recording and accounting work of the commercial side. 3000 w. The Engineering Magazine—April, 1903.

*A Practical System of Mine Accounting. E. Jacobs. The methods of the Le Roi, B. C., Mines, with reproduction of all the forms, blanks, book rulings, and record sheets. 3000 w. The Engineering Magazine—May, 1903.

A Work-in-Progress Record. Horace L. Arnold. Describes two forms in use in the Cottrell works for historical records of events. 2200 w. American Machinist—April 23, 1903.

A Work-in-Progress Record. Kenneth Falconer. Gives forms used by the writer to furnish a history of each productive order. 1000 w. American Machinist—May 28, 1903.

A Card Purchasing System. W. R. Gaither. Purchasing system for street and electric railways. 600 w. Street Railway Journal—May 30, 1903.

A Graphical Daily Balance in Manufacture. H. L. Gantt. A continuation of a former paper by the author calling particular attention to the method of setting the task and the method of operating the system by which an exact record is kept. 3800 w. Trans. American Society of Mechanical Engineers—June, 1903.

Methods of Calculation in Machine Construction (Ueber Kalkulations-Methoden in Maschinenbau). Sigm. Stephan Récsei. A discussion of the fundamental methods of computing factory costs in machine building, deriving formulas, and comparing methods of wages, depreciation, inventory, etc. Two articles. 8000 w. Zeitschrift des Oesterreichischen Ingenieur und Architekten Vereines—Aug. 7 and 14, 1903.

A Shop Cost System. Lin. Wood. Describes a system for finding and keeping the shop cost of work produced, which may be applied to almost any shop. 1400 w. American Machinist—Aug. 27, 1903.

Pratt's Record Scroll. Horace L. Arnold. Illustrates and describes this scroll, and states its advantages. 1400 w. American Machinist—Sept. 17, 1903.

Mine Accounting. Walter M. Jeffery. Read before the Lake Superior Mining Inst. Shows the importance of uniform systems for all mines under same ownership. 3400 w. Mines & Minerals—Oct., 1903.

A Card System for Mine Supply Accounts. F. W. Denton. Read before the Lake Superior Mining Inst. Describes a method by which the amount and value of supplies on hand can always be known. 1800 w. Mines & Minerals—Oct., 1903.

*Manufacturing: Capital, Costs, Profits and Dividends. Henry Hess. Developing an improved graphical method of analyzing and interpreting cost accounts and works records. An important paper. 3500 w. The Engineering Magazine—Dec., 1903.

The Preparation of Estimates. Analysis of the reasons for the great disparity in estimates for the same work, and study of the conditions which will ensure more uniformity. Serial. 1st part. 2800 w. Engineer, London—Jan. 1, 1904.

The Cost-Keeping System of Ludwig Loewe & Co., Berlin (Die Berechnung der Lohn Kosten in der Fabrik von Ludwig Loewe & Co. A.-G. in Berlin). M. Chr. Elsner. Giving reproductions of the forms and the methods of using them for obtaining the flat factory cost of manufacture. 2000 w. Zeitschrift des Vereines Deutscher Ingenieure—Jan. 9, 1904.

Two Card Systems for the Shop. H. C. Hammack. A card-index method of keeping employee's records, and a "follow-up" system for manufacturers and jobbers. 2500 w. Iron Trade Review—Feb. 4, 1904.

A Card-Index System for Obtaining the Cost and Distribution of the Non-Productive Labor. George P. Pearce. 2300 w. American Machinist—Feb. 11, 1904.

Card Systems and Diagrams—Keeping Track of Stock-Factory Management. J. S. V. Bickford. 2200 w. American Machinist—April 14, 1904.

*Cost-Keeping and Shop Statistics for a Repair Shop. A. W. Thompson. Illustrated description of a practical system in the repair shops of the Amoskeag and Manchester (N. H.) textile mills. 3000 w. The Engineering Magazine—May, 1904.

Depreciation.

*The Depreciation of Plant and Its Relation to General Expense. H. M. Norris. The practice of a number of metal-working establishments in cost-keeping, with reference to charges for depreciation of machines. 4300 w. The Engineering Magazine—Feb., 1899.

*Machine-Tool Depreciation as an Element of Manufacturing Cost. H. M. Norris. Discussing the practice of various establishments, and suggesting a solution of the problem from the author's experience, with forms and tables. 4500 w. The Engineering Magazine—March, 1899.

*Depreciation as an Element of Machine-Shop Cost-Keeping. H. M. Norris. The relation of depreciation to general expense, showing the various methods adopted in writing off plant and the use of cost diagrams. 4500 w. The Engineering Magazine—April, 1899.

Sinking-Fund Charges. W. H. Booth. A discussion of the best method of dealing with depreciation of a plant and buildings, and related matters. 3300 w. Tramway & Railway World—April 9, 1903.

Foundry.

Itemized Cost of Castings. Robert Grimshaw. A system of cost accounting for foundry work as carried out in a leading manufacturing establishment. 1400 w. Machinery—March, 1896.

Foundry Costs. R. C. Cunningham. Calls attention to points affecting the economy, and offers suggestions. 1800 w. Jour. American Foundrymen's Ass'n—June, 1901.

Foundry Accounting. J. G. Stewart. Examines in detail methods of keeping records, and remarks on the importance of knowing accurately the cost of work, etc. 5000 w. Jour. American Foundrymen's Ass'n—June, 1902.

Foundry Costs. R. C. Cunningham. Suggestions for improving the output and diminishing the costs, by supplying needed tools, careful oversight, etc. 1700 w. Jour. American Foundrymen's Ass'n—June, 1902.

*The Recording and Interpreting of Foundry Costs. Percy Longmuir. A discussion of practical methods from the point of view of the manager, with numerous tables and diagrams. 2000 w. The Engineering Magazine—Sept., 1902.

The Cost-Keeping Systems of an Ohio Jobbing Foundry. Outlines the system used in a foundry employing a large force of workmen on a great variety of work. 1200 w. Iron Trade Review—Sept. 4, 1902.

Cost-Keeping in Foundries. Edward Kirk. Arguing that nothing of value is gained, and the labor really adds to the cost of castings. 2800 w. Foundry—Feb., 1903.

Foundry Accounting and Methods of Estimating Cost of Castings. O. C. Barrows. Read at meeting of the New England Foundrymen's Ass'n. Describes a method that has proved satisfactory. 3500 w. Iron Trade Review—April 16, 1903.

An Order System for Foundries. J. Byron Henry. Methods in shops with a large output that make a specialty of jobbing orders. 1200 w. Foundry—May, 1903.

Foundry Costs: Their Analysis and Reduction. Henry Hess. Outlines a successful method. Discussion. 4000 w. Proc. Engineers' Club of Philadelphia—Jan., 1904.

Patterns.

Pattern Shop Cost. A. Sorge, Jr. A method which gives classified costs in a readily comparable form; restricted in this article to wood patterns, but can easily be extended to metal patterns. 6000 w. Iron Age—June 18, 1896.

Numbering and Storing Patterns. S. A. Worcester. The arrangement of shelves and other features. 1000 w. American Machinist—April 30, 1903.

Pattern Costs. R. W. Mac Dowell. Explains a system of keeping accurate costs of patterns, giving forms used. 1500 w. Iron Trade Review—May 5, 1904.

DRAWING ROOM.

A System of Drawing-Room Records. The outgrowth of a process of trial covering an extended period. 1500 w. Machinery—Dec., 1896.

The Decimal Index in the Drafting Room. H. W. Alden. Describes a system providing a simple and ready reference for drawing, and a logical pattern number which indicates the use for which the pattern was intended. 2000 w. American Machinist—Feb. 4, 1897.

Office Furniture, Engineering Department, Metropolitan Water Works. Giving details of drawing cases, drawing tables, blue print apparatus, etc., as used by the Metropolitan Water Board, Boston. 3500 w. Engineering Record—Sept. 17, 1898.

The Drawing Office. C. E. Hodgkin. Read before the Falcon Works Engng. Soc. On the importance of good delineation, the functions of draftsmen, etc. Serial. 1st part. 2500 w. Practical Engineer—Sept. 1, 1899.

Office System for Drawings. Henry R. Towne. Trans. American Society of Mechanical Engineers—Vol. V, 1884. Also in Mechanics—June and July, 1884.

*The Modern Mechanical Drawing Room. Prof. C. W. MacCord. A discussion of proper arrangement, furnishing and system. 3500 w. The Engineering Magazine, Sept., 1894.

Drawing Office Method. J. R. S. in "New York Railroad Men." An outline of methods used in practice respecting indexing, drawing, scales, tracings, numbering drawings, etc. 600 w. Railroad Car Journal—Nov., 1895.

The Gates Iron Works Drawing Room. John Randol (H. L. Arnold). Illustrated detailed description, with plan of room, etc. 2200 w. American Machinist—Jan. 16, 1896.

Hints for the Drafting Room. W. S. Huyette. Practical suggestions, particularly with reference to keeping records of constructive changes. 1200 w. Machinery—March, 1896.

System in the Drafting Room. James C. Hemphill. Illustrated description of a system in actual use for arranging, classifying and indexing miscellaneous drawings for easy reference. 700 w. Machinery—Nov., 1896.

A Model Drafting Room. Illustrates and describes a convenient arrangement with novel features. 1500 w. Machinery, N. Y.—Jan., 1900.

The New Drawing Office of the Schenectady Locomotive Works. Illustrated description of an office with the best facilities. 1500 w. American Machinist—Jan. 18, 1900.

A Modern Drafting Room. Illustrated description of a room in which the heating, lighting and ventilation are special features. 1200 w. Machinery, N. Y.—Feb., 1900.

The New Drafting Room of the Brown & Sharpe Manufacturing Company. L. D. Burlingame. Illustrated detailed description of a finely equipped room. 2000 w. American Machinist—March 8, 1900.

Drafting Department, Union Iron Works. Illustrated description of the special drafting building, furniture and methods of management. 3000 w. Engineering Record—March 10, 1900.

Drawing-Office System of the Bullock Electric Manufacturing Company. W. H. Warren. Describes some features of the room and its furnishings, and the system used. 3800 w. American Machinist—June 7, 1900.

Rules for a Drawing Office. A. W. Robinson. 1500 w. Trans. American Society of Mechanical Engineers, No. 897—May, 1901.

Drafting-Room and Shop Systems. Frederick O. Ball. A description of systems, with illustrations. 4000 w. Trans. American Society of Mechanical Engineers, No. 909—May, 1901.

An Outline of the Drawing-Office System of the General Electric Company. S. L. G. Knox. Describes a system found satisfactory in an establishment employing over three hundred draftsmen and having a total of over twelve thousand men. Ill. 3000 w. American Machinist—July 25, 1901.

Indexing Railway Maps and Drawings. R. C. Vial. Describes a system which has proved satisfactory in the drafting-room of the Chicago & Western Indiana R. R., based on the decimal system. 5,000 w. Engineering News—Sept. 5, 1901.

A Decimal System for Numbering Working Drawings. Henry L. Hutson. Describes a system similar to the Dewey Decimal System. Also editorial. 2000 w. American Machinist—Dec. 26, 1901.

Drawing Room; Chief Engineer's Office; Pittsburg & Lake Erie R. R., Pittsburg, Pa. R. P. Forsberg. Illustrated description of the room, tables, card-index system, drawings, filing cases, blueprint room, etc. 3200 w. Engineering News—Jan. 2, 1902.

Average Drawing-Room Practice. C. E. Coolidge. Gives questions sent out by Prof. Barr, of Sibley College, Cornell, and the replies received, with a view of forming an average system. 1600 w. American Machinist—June 19, 1902.

Standard Drawings. Warren E. Willis. Gives suggestions for drafting-room standards. 1600 w. Machinery, N. Y.—Aug., 1902.

*The Relations of the Draftsman to the Workshop. W. H. Booth. A discussion of this fundamental question of efficient shop organization, including the preparation and execution of designs for engineering work. 3000 w. The Engineering Magazine—Oct., 1902.

The Lodge and Shipley Drawing Room. Illustrated description of a well arranged office having features of interest. 1500 w. Machinery, N. Y.—Oct., 1902.

Numbering and Filing Drawings. S. A. Worcester. An outline of a system recommended, with a brief comparison with other methods. 1800 w. American Machinist—April 16, 1903.

Drawing-Office Equipment. John McGeorge. Discusses light, natural and artificial, space allotted to each man, types of drafting boards, sanitary arrangements, blue print facilities, etc. 3000 w. Ill. Trans. American Society of Mechanical Engineers—June, 1903.

Some Features of the Drawing-Office System of the C. W. Hunt Co. Description, with illustrations. 1600 w. American Machinist—July 9, 1903.

Mechanical Drawing and Its Relation to Practical Shop Work. L. D. Burlingame. An address before the Eastern Manual Training Ass'n. Considers the drafting department as the interpreter to the shop, of the shop, and for the shop. 4000 w. American Machinist—July 30, 1903.

A Filing and Indexing System for Drawings. E. C. de Wolfe. Describes the system used by the Dodge Mfg. Co., at Mishawaka, Ind. Serial. 1st part. 3000 w. American Machinist—Nov. 12, 1903.

A Modern Drawing Office. Joseph Horner. Considers the requirements, giving hints on the filing of drawings and plans, and discusses the equipment of the pattern shop and allied questions. 2400 w. Page's Mag—Dec., 1903.

Systematizing Drawing-Office Standards. The first of a series of articles intended to illustrate a method of organized work, especially in that connected with stationary steam-engine plants. Serial. 1st part. 1200 w. Practical Engineer—Dec. 18, 1903.

The Group Drawing-Office System. Walter Ferris. Describes this system as used by the Bucyrus Co. 3400 w. American Machinist—Jan. 28, 1904.

WAGE SYSTEMS.

Wages and Hours of Labor in Great Britain and Ireland. Synopsis of report published by the Labor Dep't of the British Board of Trade. Tabulated statistics, etc. 2700 w. Bulletin Dept. of Labor—Jan., 1896.

Continental and English Wages. A comparison of wages in steel works. 700 w. Iron & Coal Trades Review—Feb. 7, 1896.

The Labor Question in an English Foundry. R. A. Hadfield. Discussion of day labor vs. piece work and other matters. 2200 w. American Machinist—March 19, 1896.

The Statistics of Wages and the Cost of Living. The seventh and closing lecture in the special course on Social and Industrial Statistics, by Carroll D. Wright, U. S. Com'r of Labor, at the School of Social Economics, New York. Abstract by J. B. Walker. 1000 w. Scientific American Sup—March 28, 1896.

Labor's Value. W. S. Rogers. Experience with different systems of wage payment. Incidentally gain-sharing and profit-sharing are criticized. Serial. 1st part. 2400 w. Machinery—April, 1896.

Wages in the Engineering Trade. J. Stafford Ransome. Investigation of the inequalities in wages in different parts of Great Britain. Serial. 1st part. 2000 w. Engineer, London—April 3, 1896.

Recent Foreign Statistical Publications. General report on the wages of the manual labor classes in the United Kingdom, with tables of the average rates of wages and hours of labor of persons employed in several of the principal trades in 1886 and 1891. 5000 w. Bulletin Dept. of Labor—May, 1896.

Piece-work vs. Day's Work. Robert Grimshaw. Shows that what might be best for one shop or set of men might prove a failure under different circumstances. 1400 w. Railroad Car Journal—Jan., 1897.

Fair Wages. Editorial discussion of the report by the Select Committee appointed to consider the working of the Fair Wages Resolution passed by House of Commons. 2500 w. Engineering—Nov. 26, 1897.

Rates of Wages and Hours of Labor. Comments on information given in the recent report of the Commissioner of Labor on "Changes in Rates of Wages and Hours of Labor in the United Kingdom." 1800 w. Journal Gas Lighting—Aug. 23, 1898.

Wages and Hours of Labor. Editorial on the report from the Labor Dept. of the British Board of Trade, urging the desirability of avoiding fluctuations in wages. 2000 w. Engineering—Aug. 26, 1898.

The Evolution of High Wages from Low Cost of Labor. Edward Atkinson. Read before Am. Assn. for the Advancement of Science. 5500 w. Appleton's Popular Science Monthly—Oct., 1898.

Some Valuable Wage Statistics. Considers statistics given in Sept. number of the "Bulletin of the U. S. Dept. of Labor." 2000 w. Gunton's Mag.—Jan. 1899.

*Systems for the Remuneration of Labor. P. J. Darlington. A critical examination of the claims of the premium system, in comparison with the piece-rate method, showing the deficiencies of the former. 4500 w. The Engineering Magazine—Sept., 1899.

Piece-Work and Premium Plan. R. T. Shea. Opposed to the premium plan, and favoring piece-work. Also editorial. 2500 w. Locomotive Engineering—Jan., 1900.

Wages Paid Mechanics in the Private Shipyards of Foreign Nations. Information of importance from a standpoint of competition in vessel construction. 2200 w. Marine Engineering—May, 1900.

*New Shop Methods a Corollary of Modern Machinery. Editorial showing that labor's opposition to the new wage system is like its former opposition to machinery, and equally futile. Improved machinery and intensified production are parts of the same movement. 1800 w. The Engineering Magazine—June, 1900.

*The Application of Piece Work and the Premium Plan. Sir B. C. Browne. A discussion of the importance and relative fields of the premium and piece-work systems from a British view-point. 3300 w. The Engineering Magazine—Feb., 1901.

The Economic Status of Wages. Edward Howell Putnam. A discussion of this subject, especially as applied to foundry work. 5400 w. Journal American Foundrymen's Assn.—June, 1901.

What Shall Fix Fair Wages? Editorial discussion of what is a fair wage, with reference to strikes and other labor problems. 2000 w. Engineering News—Aug. 1, 1901.

Compensation of Skilled Labor. J. Richards. Discussion of this subject by one who is himself a practical workman and who has large experience in directing work and arranging compensation, etc. 6500 w. Journal Assn. of Engineering Societies—March, 1902.

The Inefficiency of the Wages System. Discusses wages system in England and the possibility of improving or superseding it. 2800 w. Journal Gas Lighting—May 27, 1902.

History of the Sliding Scale. From the *South Wales Daily News.* 1500 w. Iron & Coal Trades Review—Aug. 8, 1902.

*The False Economy of a Low Wage Rate. Percy Longmuir. Showing the inefficiency of cheap labor, and the wastefulness of ill-nourished workers, as compared with the productiveness of higher paid workmen. 3500 w. The Engineering Magazine—Nov., 1902.

*The Real Economy of a High Wage Rate. Percy Longmuir. A discussion of the effect of a high wage rate as a stimulus to the industry and capacity of skilled workers, and hence as an undoubted source of economy to the employer. 3000 w. The Engineering Magazine—Dec., 1902.

Gift Propositions for Paying Workmen. Frank Richards. Discusses the premium plan and the bonus system, and gives the writer's views. 3000 w. Trans. American Society of Mechanical Engineers, No. 0966—Dec., 1902.

Experience with the Premium and Piece-work Systems. R. J. Sutton. Discusses the attitude of labor organizations. 2400 w. Iron Trade Review—Sept. 3, 1903.

Plan to Establish a Machine Rating in a Locomotive Machine Shop, with Special Reference to New Tools. J. F. De Voy. Explains a system of card rating, giving information relative to the work to be performed. General discussion. 7500 w. Proc. Western Railway Club—Dec. 15, 1903.

Piece-Work, Premium and Bonus Systems. Harrington Emerson. Contribution to the discussion of a paper by Frank Richards, at Dec. meeting of American Society of Mechanical Engineers. 2000 w. Railroad Gazette—Jan. 15, 1904.

High Unit Labor Cost and Its Effect on Prosperity. Thomas D. West. 2500 w. Iron Trade Review—March 17, 1904.

Exact Time Study as the Basis of Pay for Work Done. H. L. Gantt. Read at the Philadelphia meeting of the National Metal Trades Assn. The difficulties of adjusting the payment of labor, and the effect on the output of plants. 2800 w. Iron Trade Review—March 31, 1904.

*Wage-Paying Methods from the Viewpoint of the Workman. Henry Hess. A graphical comparison of day-rate piece-work, bonus, and premium systems. 3500 w. The Engineering Magazine—April, 1904.

*Wage-Paying Methods from the Viewpoint of the Employer. Henry Hess. Discussion, with diagrams. 3000 w. The Engineering Magazine—May, 1904.

Wage-Paying Methods from the Viewpoint of Invested Capital. Henry Hess. Discussion, with diagrams. 2200 w. The Engineering Magazine—June, 1904.

Estimating Time for Lathe Work. Henry Hess. Methods in use, with charts. 3000 w. Machinery—May, 1904.

A Rational Basis for Wages. Harrington Emerson. Discusses what it is that the wage earner has to sell and why he should be paid for extra skill, and special devotion to his work. 4800 w. Trans. American Society of Mechanical Engineers, No. 022—June, 1904.

Bonus System.

A Bonus System of Rewarding Labor. H. L. Gantt. Describes a system of wages used in the machine shop of the Bethlehem Steel Co., in which a bonus is given when a job is completed within a certain time which has been fixed after careful experiments. 600 w. Trans. American Society of Mechanical Engineers, No. 928—Dec., 1901.

The Bonus System of Rewarding Labor. H. L. Gantt. Explains the work of Mr. Fred. W. Taylor, as this system was an outgrowth from his investigations, showing the advantages and the working of the system. 2000 w. Review of Reviews—Sept., 1902.

Equitable Labor Compensation and Maximum Output. H. L. Gantt. Principles and application of the bonus system. 3500 w. Cassier's Magazine—April, 1904.

Piece Work.

Piece-work on Locomotives. Classification for piece-work for an 8-wheel passenger locomotive as adopted by a leading railroad. Railroad and Engineering Journal—Jan., 1892.

A Piece-Work System. F. W. Taylor. Reviewed above. Trans. American Society of Mechanical Engineers, No. 647, Vol. XVI—June, 1895.

*A Piece-Rate System and Workshop Management. Fred. W. Taylor. An article favoring payment of labor at rates determined by analysis of the labor. 4300 w. The Engineering Magazine—Jan., 1896.

Piece Work in Car Shops. G. L. Potter. A paper before the Western Railway Club, discussing the application of piece work to repair work especially, the conclusion being strongly favorable to the system. Illustrations of actual practice and of the forms in use in standard car shops. 2300 w. Railroad Car Journal—April, 1896. Also abstract in Railway Review, March 28, 1896.

The Piece-Work System. The system adopted by the Baltimore and Ohia Railroad is explained and a schedule of prices paid for a large number of separate parts is presented. 600 w. Railway Master Mechanic—April, 1896.

Machinists' Piece Work. M. S. Link. The piece-work system, while admitted to place workmen in their highest working capacity, is condemned as gradually extinguishing the grade of good all-around machinists. 1500 w. Machinery—Oct., 1896.

Piece Work in Repair Shops. C. F. Uebelacker. States the conditions which led to the adoption of the piece-work system, how the problem of working up a price list was solved, and general details. 3000 w. Street Railway Journal—Dec., 1896.

How Can the Elementary Rate-Fixing be Best Attained for Use in Establishing Piece-Work Prices in the Railway Paint Shop? Papers by Messrs. Ball and Lanfersick before the American Master Car and Locomotive Painters' Association. 2400 w. Railroad Car Journal—Oct., 1897.

Regarding Piece Work. Editorial discussion of the advisability of adopting the piece-work system in railway shops. 1800 w. Railway and Engineering Review—Nov. 11, 1899.

*Piece Work Not Essential to Best Results in the Machine Shop. James O'Connell. An official statement of the attitude of American organized labor. 3600 w. The Engineering Magazine—June, 1900.

*Piece Work as an Agency in Machine-Shop Cost Reduction. M. Cokely. Showing the logic and necessity of a wage system providing reward and penalty. 3000 w. The Engineering Magazine—Nov., 1900.

*The Taylor Differential Piece-Rate System. Sanford E. Thompson. An exposition of the method of fixing piece rates which has proved so successful in large establishments in the United States. 5000 w. The Engineering Magazine—Jan., 1901.

Piece Work. Its Evils and Remedies. Gilbert Fox. Discusses this system and its working. 2200 w. Practical Engineer—Jan. 10, 1902.

Theory of Compensation of Labor. A discussion of the proper way to introduce piece-work systems in railroad shops. Serial. 1st part. 1600 w. American Engineer and Railroad Journal—March, 1902.

Time Required to Turn a Piece. Robert Grimshaw. Information concerning the time required to perform machine-tool operations. 1000 w. Iron Trade Review—Sept. 4, 1902.

Piece Work in a Locomotive Erecting Shop. J. Korns. Gives suggestions based upon successful experience. 1000 w. American Engineer and Railroad Journal—Dec., 1902.

Piece Work in Railway Shops. Gus Giroux. Read before the Canadian Railway Club. Shows the advantages of this system and gives suggestions for introducing it. 3500 w. Railway Age—Dec. 26, 1902.

The Piece-Work System from a Piece-Workers' Standpoint. H. B. Kepner. The first of a series of articles discussing the advantages and disadvantages of the system. Serial. 1st part. 1300 w. American Engineer and Railroad Journal—June, 1903.

*A Remodeled Piece-Work System. John H. Van Yorx, Jr. A practical working description of a plan designed to give a maximum of the necessary detailed information with a minimum of clerical work by any of the shop employees. Illustrated with fac-similes of all the forms used. 4000 w. The Engineering Magazine—Aug., 1903.

Inspection and Quality of Product in Piece Work. Translated from the *Gewerblich-Technischer Ratgeber*. Describes methods of testing and forms of penalties for bad work. 2500 w. American Machinist—Aug. 13, 1903.

The Fixing of Piece-Work Rates. Hugo Diemer. Details of experience in the accurate fixing of piece-work rates and the determination of speed records. 3000 w. The Engineering Magazine—Nov., 1903.

Is Anything the Matter with Piece Work? Frank Richards. A discussion of the merits of "piece work" and of the "premium plan." 2000 w. Trans. American Society of Mechanical Engineers, No. 01—Dec., 1903.

Premium Plan.

The Premium Plan of Paying for Labor. F. A. Halsey. Reviewed above. Trans American Society of Mechanical Engineers, No. 449, Vol. XII—June, 1891.

Experience with the Premium Plan of Paying for Labor. F. A. Halsey. Outlines the plan which was described eight years ago, and presents data concerning its working in a well-known manufacturing corporation, which has had it on trial for two years. 4000 w. American Machinist—March 9, 1899.

Some Questions Regarding the Premium Plan with Answers to Them. F. A. H. Discusses the applicability of the plan to stated conditions. 1800 w. American Machinist—March 23, 1899.

The Administration of the Premium Plan. F. A. Halsey. How the plan is carried out in some of the shops where it is used. Serial. 1st part. 1800 w. American Machinist—July 6, 1899.

The Premium Plan at the Works of A. L. Ide & Sons. Herman Fernstrom. Describes the system used at these works, considering it more simple than most others. 2200 w. American Machinist—Sept. 7, 1899.

The Reference or Premium Plan. Isaac Ross. An explanation of a system that has been worked successfully for seven years. 1500 w. American Machinist—Dec. 7, 1899.

*Actual Experience with the Premium System. H. M. Norris. An account of an attempt to introduce the premium system into an American works and the obstructive attitude assumed by union labor. Two parts. 5000 w. and 3500 w., respectively. The Engineering Magazine—Jan. and Feb., 1900.

The Economics of the Premium Plan. F. A. Halsey. Abstract of a lecture before the Providence Society of Mechanical Engineers. An explanation of the system, giving figures and statements from representative concerns in its support. 3200 w. American Machinist—May 3, 1900.

The Determination of Time Limits Under the Premium Plan. George H. Hall. 1600 w. American Machinist—July 12, 1900.

*The Premium Plan of Labor Remuneration. H. M. Norris. An account of the practical working of the premium system under the immediate supervision of the writer. 4000 w. The Engineering Magazine—Jan., 1901.

Spoiled Work—Inspection and the Use of Limits Under the Premium Plan. G. H. Hall. Advocating the charging of the workman with the time required to rectify spoiled work, and work beyond the established limits of variation. 1700 w. American Macinist—Feb. 14, 1901.

A Premium System of Remunerating Labor. James Rowan. Describes a premium system of wage-payment used in marine engine manufacture. 2400 w. Inst. of Mechanical Engineers—Glasgow Congress, 1901. Also abstract in Iron and Coal Trades Review—Sept. 6, 1901.

Premium Plan of Rewarding Labor. H. M. Norris. Stenographer's report of paper read before the Engine Builders' Assn. An explanation of the system as introduced at the works of the Bickford Drill & Tool Co., Cincinnati, Ohio. 4800 w. Engineer, U. S. A.—Jan. 1, 1902. Special number.

The Premium Plan at the Works of David Rowan & Company, Glasgow, Scotland. James Rowan. Also "The Origin of the Premium Plan." A personal statement by F. A. Halsey. Descriptive article. 3700 w. American Machinist—Jan. 9, 1902.

The Premium System. An explanation of the system, discussing its advantages, and the workmen's objections, and hoping to consider every phase of the question. Serial. 1st part. 2000 w. Engineer, London—Jan. 24, 1902.

The Premium Plan at the Works of David Rowan & Company—Piece Work, the Premium Plan, and Mr. Taylor's Plan Discussed. E. G. Herbert. 2200 w. American Machinist—Feb. 20, 1902.

The Premium Plan of Paying for Labor. F. A. Halsey. An explanation of this system and a discussion of its advantages and disadvantages. 7000 w. Sibley Journal of Engineering—Mar., 1902.

The Premium Plan at the Blank Blank Engineering Works. Gives figures showing in detail and in summary the workings of the premium plan as a whole in a plant which employs about four hundred men in all departments. 2000 w. American Machinist—June 26, 1902.

The Premium System of Wages (Das Prämiensystem der Arbeiterlohnung). F. Preuss. A general discussion of the premium system, with diagrams comparing day's work and piece work with the systems of Halsey and of Rowan. 2500 w. Zeitschrift des Vereines Deutscher Ingenieure—Jan. 31, 1903.

The Premium Plan from the Workman's Standpoint. F. A. Halsey. Extracts from an address before the Civic Federation. Gives opinions from various points where the system has been tried, all favorable to its working. 2000 w. American Machinist—Feb. 5, 1903.

A Premium System Applied to Engineering Workshops. James Rowan. Gives facts gained in an experience of five years' working of the system. 4500 w. Institution of Mechanical Engineers—March 20, 1903.

A Modification of the Premium Plan. W. H. Booth. A discussion of methods of adjusting rates, with editorial criticism. 1800 w. American Machinist—April 16, 1903.

The Premium System of Remunerating Labor. John Ashford. Read before the Manchester (Eng.) Assn. of Engineers. Explains the principle of this system and the features that have developed in its working. Serial. 1st part. 3400 w. Mechanical Engineer—April 18, 1903.

*Cost Reduction by the Use of the Premium Plan. C. A. Colwell. An account of five months' practical experience in a large shop. Gives some very interesting data of cost reduction by the use of the new tool steels. Illustrated. 4000 w. The Engineering Magazine—May, 1903.

The Premium System of Wages (Das Prämiensystem der Lohnberechnung,) B. Schiller. A scientific examination of the Halsey premium system in comparison with day wages, also considering the Rowan modification and a method of the writer, together with piece work. 7500 w. Zeitschrift des Vereines Deutscher Ingeniure—Aug. 22, 1903.

The Premium System in Practice. Charles B. Cook. An explanation of the system as used in a factory. 1700 w. Iron Trade Review—Dec. 3, 1903.

A German View of the Premium Plan. B. Schiller. Abstract of a paper in the Zeitschrift des Vereines Deutscher Ingenieure, containing a critical examination of the Halsey premium plan. Serial. 1st part. 2500 w. American Machinist—Feb. 18, 1904.

*The Premium Plan of Wage Payment in a Repair Shop. Albert W. Thompson. A description, illustrated with forms, of the system which is used for part of the work done in the repair shops of the Amoskeag and Manchester, N. H., textile mills. 1500 w. The Engineering Magazine—June, 1904.

Profit Sharing.

Gain Sharing. H. R. Towne. Reviewed above. Trans. American Society of Mechanical Engineers, No. 341, Vol. X—May, 1889.

Experience with Profit Sharing. An editorial reviewing principally American experiments in this line, and pointing out the limitations. The piece-work system is considered preferable. 4500 w. Engineering—Dec. 27, 1895.

Both Sides of Profit Sharing. Frederic G. Mather. The system discussed and many examples cited where the benefits have been mutual, but concluding that neither profit sharing nor any other device will improve the situation, if there is lack of sympathy on either side toward the others. 3500 w. Popular Science Monthly—Jan., 1896.

Profit Sharing in the United States. Paul Monroe. An account of results in some fifty different establishments in the United States wherein the experiment has been tried. The conclusion is that such a system will succeed only with a select few of employers and with a certain grade of skilled or intelligent labor. 11000 w. American Journal of Sociology—May, 1896.

Profit Sharing at Ivorydale. I. W. Howerth. Presents the salient features and the results of profit sharing at the Procter & Gamble Company, engaged in the manufacture of soap, candles and glycerine at Ivorydale, Ohio. 4500 w. American Journal of Sociology—July, 1896.

Profit Sharing in England. Information obtained from Mr. George Livesey regarding the social experiment which has been successfully tried by the South Metropolitan Gas Company, of London. 4500 w. U. S. Consular Reports—May, 1897.

Profit Sharing as a Remedy. Editorial discussion of the situation in England, brought about by this strike, and of Mr. Livesey's suggestion of profit sharing. 2800 w. Engineering—Nov. 5, 1897.

Wages and Production. Arthur A. Fuller. Discussion of co-operative plans and their effect upon production. 2000 w. Machinery—March, 1899.

A Logical System of Wages. John Richards. Suggests a co-operative contract system of compensating labor, illustrating by example. 3500 w. American Machinist—Aug. 24, 1899.

Profit Sharing, or Payment by Results. G. W. Lupton. Read before the Manchester Dist. Inst. of Gas Engineers. Favorable discussion. 3800 w. Journal Gas Lighting—Nov. 28, 1899.

Mr. W. H. Lever on Profit Sharing. Discusses the objections set forth by Mr. Lever in published articles. 2500 w. Journal Gas Lighting—Aug. 27, 1901.

The Pension System and Profit Sharing. J. B. Johnston. Discusses the growing sentiment in favor of pensions to the invalided or superannuated workmen; also the subject of profit sharing, which the writer does not think an unqualified success. 1600 w. American Manufacturer—Feb. 27, 1902.

A Dividend to Labor. J. Holliday. Read before the North of England Gas Managers Assn. A few ideas on the subject of profit sharing as relating particularly to gas undertakings. 2500 w. Journal Gas Lighting—April 29, 1902.

United States Steel to Share Profits. A copy of the circulars to stockholders and employees setting forth the plan. 4500 w. Iron Age—Jan. 8, 1903.

One Way to Cure the Trusts. Editorial discussion of the plan of the United States Steel Corporation devised to induce officers and employees to become stockholders. 1700 w. Railroad Gazette—Jan. 9, 1903.

Profit Sharing in America. Editorial discussion of the scheme of the United States Steel Corporation. 3200 w. Engineering—Jan. 23, 1903.

The Steel Corporation Points the Way. Walter Wellman. An explanation and discussion of the wage earners' investment and profit sharing plan. 6000 w. Review of Reviews—March, 1903.

The Labor Capitalist. Frank C. Perkins. Suggests that the laboring classes acquire stock in the industrial enterprises and have a voice in the management of the industries. 3000 w. Cassier's Magazine—June, 1903.

*A Project for a Capitalized Labor Organization. C. L. Redfield. Suggestions for the establishment of business relations between capitalized labor and capitalized employers, instead of the present conflicting conditions. 3000 w. The Engineering Magazine—Sept., 1903.

Profit Sharing and the Premium Plan. Kenneth Falconer. A plan of profit sharing based on the principles of the premium plan of paying wages. 1800 w. Cassier's Magazine—Dec., 1903.

GENERAL MANAGEMENT.

Management of Men. Editorial. Engineer, London—Dec. 25, 1885.

Economical Shop Management. Fred H. Colvin. The proper relations between superintendent, foremen and workmen, and other questions. 1800 w. American Machinist—Aug. 16, 1894.

The Evolution of the Workshop. C. John Hexamer. 4800 w. Journal Franklin Inst.—Sept., 1894.

*The Management of Men in Mills and Factories. W. H. Wakeman. Showing the advantage of treating men with consideration. 2500 w. The Engineering Magazine—Oct., 1894.

*Economy in Machine Shop Management. James Brady. Description of workmen's time cards and of various handy mechanical methods and devices. Illustrated. 3000 w. The Engineering Magazine—Dec., 1894.

*The Educational Influence of Machinery. Alexander E. Outerbridge, Jr. Showing the educating and elevating influence of machinery upon the mind of the workingman. 3000 w. The Engineering Magazine—May, 1895.

*Production Up to the Power Limit. Horace L. Arnold. A discussion of the policy of driving men and tools hard, particularly as practiced at the Baldwin Locomotive Works. 3500 w. The Engineering Magazine—Aug., 1895.

*The Emancipation of Labor by Machinery. Alex. E. Outerbridge, Jr. Showing the beneficent influence of machinery upon the wage-earner. 3500 w. The Engineering Magazine—Sept., 1895.

The Treatment of Trades Waste. Willian Naylor. Abstract of a paper read before the Institute of Civil Engineers. A résumé of progress in reducing waste in a great variety of manufacturing industries. 6000 w. Industries and Iron—Dec. 27, 1895.

On Wastes and Shop Handling. John Richards. Extracts from recent lectures before the students of Leland Stanford Junior University, Palo Alto, Cal. Percentage that should be added for waste, in estimating cost of machinery, methods of arriving at weights through dimensional data, and suggestions to designers. 1600 w. Iron Trade Review—Jan. 23, 1896.

Studies in Economic Practice. C. B. Fairchild. Describes shop methods, tools and devices of the Chicago City Railway. Serial. 1st part. 4000 w. Street Railway Journal—July, 1896.

Points in Shop Management. B. F. Fells. Need of thorough-going, alert mechanics. Shiftless ways in some shops lately seen. 1000 w. Iron Trade Review—July 30, 1896.

An Industrial Democracy. C. R. Richards, in *Pratt Institute Monthly*. Describes the industrial system in operation in the works of the National Cash Register Co., at Dayton, Ohio. 2200 w. Scientific American Sup.—Sept. 5, 1896.

*Six Examples of Successful Shop Management. Henry Roland (H. L. Arnold). A series of articles in the Engineering Magazine—Oct., Nov., Dec., 1896, Feb., March and April, 1897.

No. 1. Labor conditions in the Whitinsville shops. Illustrated. 4200 w.

No. 2. Cheney Silk Mills, South Manchester, Conn. 4000 w.

No. 3. Methods of the Yale and Towne Co. in dealing with their employees. Illustrated. 5300 w.

No. 4. Piece-rate systems in use by the Baldwin Locomotive Works, the Midvale Steel Co. and Wm. Sellers & Co. 3400 w.

No. 5. Decline of the contract system in machine shops. 3200 w.

No. 6. The pension, insurance and endowment feature of the earning-division plan at Alfred Dolge & Co.'s. 4800 w.

The Commercial Organization of Factories. Review of a book by J. Slater Lewis for manufacturers, directors, engineers, secretaries, accountants, draughtsmen, etc. 4000 w. Iron & Coal Trades Review—Nov. 27, 1896.

Economical Production in Engineering Workshops. How to produce work at the lowest possible cost, without any drawbacks. Serial. 1st part. 1700 w. Machinery, London—Dec. 15, 1896.

*Labor-Saving Machinery, the Secret of Cheap Production. A. E. Outerbridge, Jr. Showing that an ascending wage-scale is an essential of prosperous productivity. 3200 w. The Engineering Magazine—Jan., 1897.

An Unique Manufacturing Establishment. The first of a series of articles purposing to give an idea of the factory of the National Cash Register Co., of Dayton, O., and of the spirit that pervades it. Illustrated. Serial. Ist part. 4500 w. American Machinist—March 25, 1897.

Manufacturing Methods as Applied to the Production of Machinery. F. A. Halsey. The methods described relate specially to manufacture by aid of special fixtures, and refer to pure machine-shop operations only. 3300 w. Sibley Journal of Engineering—June, 1897. Also abstract in American Machinist—Aug. 19, 1897.

Works Management. General principles with some suggestions of detail. 2800 w. Engineering —June 25, 1897.

The Management of Small Engineering Workshops. R. W. R. The first of a series of articles which will consider the management of small shops, employing up to 150 to 200 hands, confining the attention to the internal working. Serial. 1st part. 1700 w. Practical Engineer—Aug. 13, 1897.

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The Works of the American Tool Works Company. Illustrated description of these works, the departments, methods, packing, show cabinets and processes. 3000 w. Iron Age—April 21, 1898.

Some Considerations Affecting the Location and Design of Machine Shops. Concerning the new shops of the Lane and Bodley Co., of Cincinnati. 1500 w. American Machinist—Sept. 28, 1899.

Comfortable Work Shops. Editorial on the profitableness of keeping shops comfortably warm, well lighted, in good sanitary condition, etc. 1700 w. Iron Age—Nov. 8, 1900.

*Shop Arrangement as a Factor in Efficiency. H. F. L. Orcutt. A discussion of the design of an engineering works as a great tool, by the designer of the works of Ludwig Loewe & Co., of Berlin. 3000 w. The Engineering Magazine—Jan., 1901.

*The Economy of Heating and Ventilating the Machine Shop. L. Allen. A discussion of the influence of personal comfort upon individual efficiency, showing how bad hygienic conditions reduce quality and rate of output. 3000 w. The Engineering Magazine—April, 1901.

The Ventilation, Lighting and Cleanliness of Small Workshops. John Robertson. 3000 w. Plumber and Decorator—Dec. 2, 1901.

Bricklaying at the British Westinghouse Works. J. C. Stewart, in the London *Times*. Explains the method adopted to double and triple the rate of bricklaying per man in Great Britain. 1700 w. Engineering Record—March 29, 1902.

The Plant of the Bullock Electric Manufacturing Company and Its Work and Cost System. Illustrated detailed description of one of the finest modern plants, located near Cincinnati, and its methods. 5000 w. Iron Trade Review—April 3, 1902.

Messrs. David Rowan and Co.'s Works, Glasgow. An illustrated detailed description, with discussion of the engineering economy in the management of such works. 5400 w. Engineering—May 9, 1902.

The German Niles Tool Works, Berlin. Begins an illustrated detailed description of these interesting works, where American and German systems of engineering are combined. Serial. 1st part. 5600 w. Engineering—May 30, 1902.

Shop Construction. Oscar E. Perrigo. The first of a series of illustrated articles upon the design and construction of machine shops, with hints upon the arrangement of tools, and the management. Serial. 1st part. 2200 w. Machinery, N. Y.—Oct., 1902.

The Ventilation of Workshops. Reviews the first report of the Commissioners inquiring into the ventilation of factories and workshops. Deals only with general ventilation. 2200 w. Iron & Coal Trades Review—Nov. 7, 1902.

Notes on the Krupp Works (Einiges über Krupp). A brief review of the development of the Krupp works, with plate of illustrations showing views in the works and plans and elevations of the workmen's houses. 1200 w. Oesterreichische Zeitschrift für Berg und Hüttenwesen—Nov. 29, 1902.

The Designing and Construction of Modern Engineering Workshops. J. H. Humphreys. Read before the Manchester (England), Ass'n of Engrs. An illustrated discussion of stanchions, crane girders, floors, and floor girders, roof principals, and bracing. Serial. 2 parts. 4500 w. Mechanical Engineer—Dec. 13 and 20, 1902.

The Ventilation of Factories. Abstract of the "First Report of the Departmental Committee Appointed to Inquire Into the Ventilation of Factories and Workshops," with editorial comment. 3000 w. Engineer, London—Jan. 9, 1903.

The Laying Out of Engineers' Workshops. Joseph Horner. The first of a series of articles concerning the conditions which should govern the arrangements dealing with extensions of old works, laying out of new, etc. Serial. 1st part. 3000 w. Page's Magazine—March, 1903.

Machine-Shop Equipment. Oscar E. Perrigo. The present article considers planning the different departments, suggesting the proper selection and arrangement of machines. Serial. 1st part. 3700 w. Ill. Machinery, N. Y.—Sept., 1903.

*The Tools and Methods of a Swiss Locomotive Works. C. R. King. An illustrated description of the Swiss Locomotive and Machine Works at Winterthur, showing a union of English, American and Continental practice. 3500 w. The Engineering Magazine—Sept., 1903.

A Model Bridge and Construction Shop. An illustrated detailed description of the Pennsylvania Steel Company's new plant at Steelton, Pa. 3500 w. Iron Age—Sept. 10, 1903.

The Pennsylvania Company's Model Bridge Plant. Part first gives an illustrated description of the general arrangement and principal features of the plant at Steelton, near Harrisburg, Pa. Serial. 1st part. 5700 w. Engineering Record—Sept. 26, 1903.

The Ambridge Plant of the American Bridge Company. An illustrated description of the arrangement, operation, power, transportation and buildings. Serial. 1st part. 5500 w. Engineering Record—Nov. 21, 1903.

Suggestions for Shop Construction. F. A. Scheffler. Describes a plan in which the various departments radiate from the administration building. Diagram. 900 w. Trans. American Society of Mechanical Engineers, No. 09—Dec., 1903.

Modern Workshop Design. A. Pringle. The bearing of the class of work upon the design and equipment of shops; the important features, the materials, roofing, etc., are discussed. 5200 w. Canadian Society of Civil Engineers, Adv. Proof—Dec., 1903.

The New Henry R. Worthington Hydraulic Works at Harrison, N. J. Illustrated description of a very large and complete manufacturing plant. Serial. 1st part. 5000 w. Engineering Record—Feb. 6, 1904.

Features of the Michigan Stove Company's Plant and Methods. Illustrated detailed description. 4000 w. Iron Trade Review—March 3, 1904.

The Economic Theory of Factory Location. Hugo Diemer. Discussion. 2000 w. Railway Age—March 18, 1904.

The Planning of Factory Buildings and the Influence of Design on their Productive Capacity. Hugo Diemer. Suggestions aiming to secure utility and economy, and with a view to future expansion. 3000 w. Engineering News—March 24, 1904.

Foundry.

*A Survey of Modern Foundry Practice. Percy Longmuir. Showing the defects of many of the older foundries and the remarkable cheapening in castings effected by the introduction of modern methods and machines. 5000 w. The Engineering Magazine—Jan., 1901.

Foundry Economy. Percy Longmuir. Briefly considers the requirements of economical castings, organization, and management. 2600 w. Iron Trade Review—March 28, 1901.

The Foundry, Its Equipment and Management. Edw. B. Gilmour. Discusses what a modern foundry should be when quantity and quick delivery are of greatest importance. Ill. 3000 w. Journal American Foundrymen's Ass'n—June, 1901.

Control of the Foundry. Percy Longmuir. On the relation of laboratory and foundry and the education needed by the manager. 1600 w. Jour. American Foundrymen's Ass'n—June, 1901.

*Opportunities for Bettering the Work of the Foundry. Percy Longmuir. States conditions as they often exist, showing that poor installations are costly, and discussing points leading to satisfactory and economical results. 3800 w. The Engineering Magazine—Oct., 1901.

The Engineer in the Foundry: A New Departure. An illustrated article prepared from the lecture of Samuel Groves, at the Buffalo Convention of the Amer. Foundrymen's Ass'n, showing the methods pursued in providing foundry appliances and equipment for the works of the Westinghouse Machine Company. 2800 w. Foundry—Dec., 1901.

Foundry Economy. Dr. Richard Moldenke. How the foundryman is to economize by the applications of scientific methods is discussed, and other suggestions are given. 2800 w. Jour. American Foundrymen's Ass'n—April, 1902.

The Relative Position of Employer and Employed. Edw. B. Gilmour. Arguments showing the interests are co-equal. 1100 w. Jour. American Foundrymen's Ass'n—May, 1902.

The Advantage of Working to Patterns and Gauges. Walter J. May. Calls attention to the advantages derived from the use of carefully made patterns and gauges in all cases where repetition work is likely to occur, especially in the foundry and smithy. 2000 w. Practical Engineer—May 30, 1902.

Some Methods of Increasing Foundry Productions. David Reid. Describes methods tried and proved successful. 1500 w. Jour. American Foundrymen's Ass'n—June, 1902.

Economy. P. R. Ramp. Calls attention to things that cause waste, and to false economy often practiced. 1400 w. Jour. American Foundrymen's Ass'n—June, 1902.

The Relation of the Molding Machine to Foundry Labor. C. H. Mumford. Address before the New England Foundrymen's Ass'n. Discusses the relation of the molding machine to union foundry labor. 3800 w. Iron Age—Nov. 20, 1902.

*Foundry Management in the New Century. Robert Buchanan. A series of seven articles. The Engineering Magazine—Dec., 1902, to June, 1903.

No. 1. The economical production of castings. Ill. 3500 w.

No. 2. Crane service and transport appliances for the foundry floor. Ill. 4500 w.

No. 3. Moulding by hand and by machine. Ill. 4500 w.

No. 4. Materials of consumption, including the purchase of coke, iron, sand, etc. Ill. 5000 w.

No. 5. The cupola and the principles involved in its successful and economical use. Ill. 4500 w.

No. 6. The dressing of castings. Ill. 3500 w.

No. 7. The qualities and training of the foundry manager. 2500 w.

Limitation of Output by Molders. James A. Murphy. Discusses the restriction of output and the attitude of the Molders' Union. 1700 w. Iron Trade Review—Dec. 4, 1902.

The Future of the Foundry Industry. Dr. Richard Moldenke. A discussion of the outlook and the labor questions involved. 2800 w. Jour. American Foundrymen's Ass'n—March, 1903.

Rigs as a Factor in Foundry Management. Edward Kirk. An article discussing the advantage of proper rigging. 1600 w. Foundry—April, 1903.

The Advantages of Having a Foundry Attached to an Existing Engineering Works in the Country. J. A. Coombs. Shows the effect in cost of castings and considers the subject generally. 1800 w. Practical Engineer—April 3, 1903.

The Organization, Maintenance and Management of a Modern Pattern Shop. Jos. Leon Gobeille. Discusses remedies and improvements needed. Ill. 1800 w. Jour. American Foundrymen's Ass'n—June, 1903.

Foundry Management. Edward Kirk. Describes conditions representing the management of fully half the foundries, and discusses improvements. 5200 w. Foundry—June, 1903.

The Equipment of the Foundry. Joseph Horner. An illustrated article discussing especially the general shop, with departments for special work. 5500 w. Cassier's Magazine—Oct., 1903.

*Labor-Saving Machinery in Foundry Operations. Dr. R. Moldenke. A fully illustrated account of the latest improvements in cranes, ladles, molding machines, conveyors, core machines, etc. 3500 w. The Engineering Magazine—March, 1904.

EDITORIAL COMMENT

THE first of our series of special numbers dealing with Labor-Saving Machinery and Methods, which appeared in March last, dealt with the fundamental element in the problem—the use of mechanical power. In this second of the group, the factors taken up are the problems of mechanical and commercial management which follow the centralization of manufacture and the intensified development of the factory system; the particular manifestation studied is that found in the machine shop—or the shop where metal cutting tools are used; for this is not only the most pertinent to the province of the Magazine, but it forms the broadest class of modern manufacturing industries. Whether the product be typewriters or engines for an Atlantic liner, many of the principles are identical; and whatever the factory may make, if it be a works of even medium size the machine shop will be the foundation of its maintenance at the point of greatest efficiency.

The concluding number of the series, which will appear later in the year, will take up a line of power applications which is perhaps the most diversified of all, and very widely useful in bettering the economy of manufacturing operations — Labor Saving by Mechanical Transport.

* * *

THE review of fire-prevention on shipboard which appears on page 678 of this number suggests one means by which such a horror as the Slocum disaster may, and very possibly will, be made far more unlikely of repetition. It is useless to talk of "the overwhelming censure of public opinion." Public censure—an ephemeral thing at most times—is of little effect against the incredible indifference and criminal negligence which open the way to such an "accident." Nor did anyone with eyes and ears need to be shown that "government inspection," under actual working conditions, becomes a mockery—hideous because of the false confidence it inspires in the multitude who might otherwise be warned to look more carefully after their own safety.

The one agency which can make, and enforce, rules which will minimize the risk is the Board of Underwriters. It has the force of a solid, coherent, and perfectly definite individuality to be dealt with. It has the practical efficiency of a sound business organization, using the best methods and the best talent the professions can supply. It has absolute power to enforce its rules under the penalty of withdrawal of insurance from those who violate them. And it cannot be bought, because there is no possible collusion with owners to the detriment of the public which would not yet more nearly betray the interest of the insurance companies themselves. When they awaken, as they are perhaps likely to do, to the conditions of the risks they are writing, and when they put this local marine business upon the same basis as they have adopted in other lines, there will be a set of rules and a system of inspection which will mean something for the safety of the passenger.

* * *

WE have referred already in these columns to the visits of various foreign engineering societies to the United States, and it is a matter for much satisfaction to record the most successful joint meeting which was held last month in Chicago by the Institution of Mechanical Engineers and the American Society of Mechanical Engineers. The welcome presence of the president of the British Society, Mr. J. Hartley Wicksteed, as well as the secretary, Mr. Edgar Worthington, together with several members of the council, enabled the convention to be conducted in every respect as a joint meeting, both presidents officiating at all the sessions, and English and American members taking active parts in the discussions.

Some of the more important papers presented at the convention are reviewed elsewhere in this issue, but it is well understood that the most valuable feature of such gatherings is found in the opportunity afforded for the interchange of opinions, the making of acquaintances, and the acquirement of suggestion.

These advantages exist in a large degree even when the members belong to but one society, but they appear to a still greater extent when engineers from different countries, with varying methods and traditions, meet and mingle in the unconstrained and congenial manner so evident at Chicago. The "republic of letters" has often been cited as demonstrating the fact that there are no national limitations to the work of the writer, but there is also a republic of engineering, a republic in which the States are the great engineering societies of all civilized lands, and in which citizenship is attained only by achievement. When the members of such a republic meet in convention, there may be no procession, no brass bands, no demonstrations of political enthusiasm, but who shall say that the results of a convention of engineers, of men who do things, are not of greater and more lasting value to the nation and to the world than those which follow any political gathering?

* * *

THERE is a tendency in papers presented before engineering societies to use, or even abuse, the opportunity afforded to advance private interests by pushing individual devices, and this fact appeared to such a degree in certain of the papers presented at Chicago as to draw forth the sharp comment of more than one member during the discussion. This method of advertising appears more generally in the cases in which large corporations attempt to utilize the services of members of the soceity in their employ. The papers submitted by individual members are, as a rule, of far more technical value than these "inspired contributions." As a matter of fact the membership at large rates such efforts at their true value. The most desirable and valuable publicity is not to be obtained in this way. An audience is secured, it is true, but the interest of the paper is marred when there is the slightest feeling created that an attempt is being made to use a professional society in an unprofessional manner.

REVIEW OF THE ENGINEERING PRESS.

"THE WORLD IS ITS FIELD"

A STEAM TURBINE SYMPOSIUM.

DE LAVAL, PARSONS, WESTINGHOUSE, CURTIS, AND RATEAU SYSTEMS COMPARED AND DISCUSSED.

American Society of Mechanical Engineers—Institution of Mechanical Engineers.

THE active interest which is felt in the development of the steam turbine is well shown by the fact that at the recent joint convention of the American and British mechanical engineers at Chicago there were four papers contributed by as many members, these occupying an entire session of the meeting for their presentation and discussion. The merits of the De Laval machine were shown by Mr. E. [illegible] Lea, while Mr. Hodgkinson discussed very ably the contruction and operation of the Parsons turbine as made in the United States by the Westinghouse company. The Curtis turbine was described by Mr. Emmet, and in conclusion Professor Rateau gave a general account of the applications of turbines, together with a detailed review of his own work in this field. As every one of these engineers is actively connected with the practical construction and operations of these machines we thus have a most valuable collection of data and information at first hand.

Historically, the growth of the steam turbine may be traced in these papers in an interesting manner. De Laval, with the single impulse wheel, and Parsons, with the multiple turbine, combining both impulse and pressure, made their results public about twenty years ago, although Tournaire had described the multiple reaction turbine as long ago as 1853, while Branca, in 1629, described and illustrated a steam wheel with a single jet acting upon a wheel, and Kircher, in 1656, improved this by applying two jets to drive the same wheel. Neither of these early authors claimed any invention in these devices, rather describing them as ideas of current knowledge, and it is interesting to note that in Branca's original illustration the turbine is shown on a vertical axis, a form lately revived. Neither Branca nor Kircher appear to have made any such machines, both men being writers rather than constructors, but they seemed to have had fairly clear ideas for their time, Branca showing his wheel as being so geared to the machinery as to permit a high rotative speed of the turbine, which he evidently felt to be a necessity. In view of the accurate mechanical workmanship and high quality of materials necessary for the practical construction of satisfactory machines it is not to be wondered that the turbine, thus early conceived, should have been laid aside for more readily constructed forms of the steam engine, while now that the fundamental principles have been made public we may expect a rapid development similar to that which followed the general entrance of manufacturers into the field of dynamo construction under like circumstances. The good work which has been done by Parsons and by De Laval in rendering the steam turbine a practical machine is well indicated by the fact that the *Verein Deutscher Ingenieure,* at its recent meeting at Frankfurt am Main, has bestowed the award of the Grashof medal upon both engineers.

The general statement of the problem is well made by Mr. Emmet, when he says:

"The expansive force in steam is capable of imparting to the steam itself very high velocities, and the problem which presents itself to the designer of steam turbines is to devise means by which the velocities of moving jets or columns of steam may be made to give up their work effectively to mechanical parts which run at practical speeds."

This problem of converting the high velocity of the steam jet into mechanical work, brings the engineer into contact with several fundamental principles. Thus, the maximum efficiency of a wheel is attained when the buckets upon which the steam acts travel at one-half the velocity of the steam which propels them. Again, the limit of rotative speed of a turbine wheel is that of the resistance of the material to the stresses due to centrifugal force. Moreover, high angular velocities require reduction by some form of gearing in order that the power may be applied to the machines which it is desired to drive. With these elements the designer also encounters the problems involved in the construction of steam nozzles which shall provide for the conversion of the expansion of the steam into velocity in a direction available for use upon the wheel. When it is considered that we really know very little about the actual behavior of steam jets in nozzles, or the losses due to friction, eddies, and internal work, it will be seen that there is yet ample room for experimental investigation and study of the elements of this most interesting problem. All the contributors to the symposium bear tribute to the excellent work which has already been done in this line by Professor Stodola, in the laboratory of the Zurich Polytechnikum, and it is to be hoped that such scientific researches will be continued and the results applied in future practical work.

Probably the most interesting feature of all in the various papers presented at the Chicago convention is the fact that the tests of the different machines under consideration show about the same steam consumption, this ranging from 14 to 16 pounds per brake horse-power hour, according to conditions. In view of such results it is evident that further lines of improvement may be expected along constructive details, since questions of convenience, size, weight, first cost, depreciation, etc., must become of controlling importance.

Higher steam economy has been attained by the reciprocating engine under special circumstances, but only with engines of large size and greater complication. When the comparison comes to be made upon the basis of economy, not merely of steam, but of money, and upon engines of moderate size, it may well be believed that any one of the turbines now on the market will make a better showing than the reciprocating engine. Indeed, it was emphasized in the course of the discussion that steam economy is a matter which is by no means always considered. Notwithstanding the high performances of the best forms of automatic and multiple-expansion steam engines there are large numbers of plain slide-valve engines built and sold every year, and these engines are bought and used by men who know very well what they are about. If it can be made to appear that the turbine, built upon any approved system, and bearing any name whatever, will give the maximum efficiency in the practical operation of converting value into more value, be it expressed in terms of money or any other equivalent, the nature of the stages of which this ultimate performance is made up become of secondary importance and interest.

For the engineer, of course, these secondary stages must be considered as falling largely to his share of the whole, and in this respect the paper of M. Rateau is of much value. Devoting a comparatively small portion to the publicity of his especial variety of machine, he shows how the turbine can be applied to the successful driving of machines as desirable as itself. The turbine makes it possible to use high-pressure centrifugal pumps, or similar blowing engines, replacing the ponderous machines now so familiar in waterworks, furnaces and mines. Thus, steam turbines, direct connected to multiple centrifugal pumps, are in operation in Bohemia, raising 400 to 600 gallons per minute against a head of more than 700 feet, with a steam consumption of less than 30 pounds per horse power measured in water lifted, this performance thus including the work of the turbine, as well as the pump and pipe resistances. When this result is compared with that of direct-acting steam pumps, including interest and depreciation, it will be seen that the turbine offers possibilities far beyond those of its own steam consumption. Fan blowers, driven by steam turbines, have been effectively employed in France for supplying wind to blast furnaces under a pressure of four to five pounds per square inch at a rate of more than 100 cubic feet per second, with a total combined efficiency of more than 38 per cent., not taking into account the difference in interest on first cost.

When we compare the transformation which was made by the substitution of the modern high-pressure, high-speed steam engine for the heavy, slow-moving beam engine of the first half of the nineteenth century, we can begin to realize the transformation which will be made by the replacement of the existing reciprocating engine by the turbine with its high rotative speed, and in this way possibly we may rid ourselves of the limited idea of considering the steam turbine solely upon its own steam consumption.

MODERN GEODESY.

RECENT PRACTICE IN THE MEASUREMENT OF BASE-LINES AND ANGLES IN EXTENDED SURVEYING OPERATIONS.

Revue Générale des Sciences—Comptes Rendus.

FOR nearly two hundred years an important portion of the work of the engineer has been involved in the various attempts which have been made to measure the form and dimensions of the earth. The problem possesses an importance not only from the viewpoint of pure science, but lies at the bottom of all the practical work of surveying, navigation, and terrestrial physics; while the principles of geodesy must enter into all surveys of which the extent is sufficient to render it necessary to take the figure of the earth into account. For these reasons the report of the committee of the French Academy, having in charge the scientific control of the geodetic operations recently conducted at the equator, and published in *Comptes Rendus,* is of present interest and value. To this may be added the extended paper of Commandant Bourgeois, the officer in charge of this work, this latter article appearing in a recent issue of the *Revue Générale des Sciences.* Both articles are really due to Commandant Bourgeois, but the limited space permissible in the pages of the *Comptes Rendus,* renders the supplementary article the more complete.

Although much important work in the measurement of various arcs has been performed by independent investigators, including the determination of the meridian of France by Cassini, and the polar and equatorial measurements, made during the middle of the 18th century, and revised at the beginning of the 19th century by Borda, Delambre, Méchain, and Legendre in connection with the formation of the metric system, it was not until quite recently that the efforts of the International Geodetic Association have arranged the systematic exploitation of the surface of the earth by which different nations have underaken to contribute their share toward an accurate solution of the whole problem.

Thus, in the United States, two great chains of triangles have been measured, the one extending from the Atlantic to the Pacific, and the other from the northern to the southern boundaries. A general account of this latter line, along the 98th meridian of longitude, was given in our issue of October, 1902, where the methods of base measurement especially are discussed. The work which is now being undertaken by Great Britain, begun in 1899, for the measurement of the length of a meridian extending from Capetown to Alexandria, is another example of the extended scale upon which the matter is being developed; this arc, when completed, including about 65 degrees, of which 30 degrees will lie on each side of the equator.

Another valuable piece of geodetic work, recently completed, is the measurement of an arc of 4.5 degrees in length on the island of Spitzbergen, this being of especial importance because of its high latitude, lying between 76 and 80.5 north latitude. This work, which was undertaken by a joint commission sent out by Russia and Sweden, was fully described in our issue for March, 1903, and is interesting especially from the fact that the new nickel-steel alloy of minimum expansion was used for the measuring tapes.

The expedition under the charge of Commandant Bourgeois has been engaged in the measurement of an arc of 6 degrees in length, this lying in the republic of Ecuador, in close proximity to the equator. This work was undertaken in accordance with the conclusions reached at the general conference of the International Geodetic Association held at Stuttgart in 1898; it being thought desirable to have a new set of measurements made upon the territory upon which Bouguer and La Condamine had made the first determination of an arc of the meridian near the equator in the 18th century. The actual work was begun in 1901, by an expedition of six officers and fifteen subordinates, their surveys extending from the Colombian frontier on the north, to the boundaries of Peru. For the details of this work reference must be made to the report of Commandant Bourgeois, but some review may here be made of the improvements on geodetic work described in his paper, to which reference has been made.

The most important element in geodetic surveying is naturally the measurement of the base lines, although it has been maintained, with some reason, that this element has received a disproportionate share of attention. The earlier base-line measurements were made with metallic bars, either compensated for variable expansion or provided with means for determining the temperatures and making subsequent corrections. The latest refinement in the bar method is that originated by the United States Coast and Geodetic Survey, using a single bar immersed in melting ice, the containing trough being carried on a suitable car upon a temporary track. This method, which undoubtedly eliminates all temperature error, is now employed mainly for testing the accuracy of the metallic tapes and wires used in the actual field work, and for this purpose it forms a valuable standard of reference.

The use of the bar in the field was displaced a number of years ago by the apparatus of Jäderin, in which the measurements are made with metallic wires under constant tension. The original Jäderin apparatus consisted of two wires, each 24 metres in length, one being of steel and the other of brass. These wires have short graduated scales attached to them at the ends, and in use are stretched by a weight of 10 kilogrammes, and supported by tripods. The two wires being of the same length at standard temperature, the difference between any simultaneous measurements made with them must be owing to their change of length due to the temperatures during the measurements, so that the wires themselves form a metallic thermometer indicating the summation of the variations in temperature during the work. This enables the temperature correction to be computed very accurately, while the length of the wires enabled the work of measurement to be conducted much more rapidly than with the old bar system. The discovery, by M. Guillaume, of the alloy of 64 per cent. of steel and 36 per cent. of nickel, this possessing an exceedingly low coefficient of expansion, has further simplified the process, a single wire of "invar," as the nickel-steel alloy has been named, replacing the two wires of the original apparatus. The measurements of the Spitzbergen survey were made with tapes of invar, and the accuracy of the results were fully verified, so that this method will doubtless become general.

The measurement of horizontal angles continues to be made in much the same manner as has obtained for twenty years past. The repeating circle, as constructed by Brünner, appears to represent the highest type of construction, but in France and in Germany the measurement of angles is often made by the method of Schreiber, all the angles being measured from each station in all the combinations which can possibly be made, these being used to check each other. The principal objection which can be made to this system lies in the fact that the illumination is not uniform in all direction, so that the various observations cannot all have the same critical value.

In addition to the horizontal measurements, both linear and angular, there are other determinations which fall within the province of geodetical survey, and these are also considered by Commandant Bourgeois. These investigations include the deviation of the vertical in various localities, the variations in the intensity of the force of gravity, and various applications of the methods of precise levelling.

The measurement of the variations in the intensity of gravity by the method of Hecker is given attention, this method consisting in a comparison, for any given place, of the indications of the mercurial barometer and the hypsometer. The latter method measures the pressure of the atmosphere by the determination of the boiling point of water, and any difference shown between its indications and those of the mercurial barometer may be considered as due to a variation in the action of the force of gravity upon the mercury. Determinations of the force of gravity in the Andes by the present expedition show such a close accord with the results of Bouguer, made more than 150 years ago, as to reflect great credit upon the work of the earlier observer.

In general, the paper and report of Commandant Bourgeois, give an excellent view of the present state of the art of geodesy, including the latest progress made in the theory and practice of surveying in its highest branches.

LIQUID FUEL TESTS IN ITALY.

DATA AND RESULTS OF TRIALS WITH PETROLEUM IN COMMERCIAL MARINE SERVICE IN THE MEDITERRANEAN.

Rivista Marittima.

LIQUID fuel has been used for a number of years on the steamships plying on the Black Sea, and the results appear to have been altogether satisfactory. More recently trials have been made in America, especially in connection with the development of the oil fields of Texas, and the reports made to the Navy Department are well known. In a recent issue of the *Rivista Marittima* is given an account, by engineer Salvatore Orlando, of the tests recently made upon the Tebe, a vessel of the Navigazione Generale Italiana, on the service between Genoa and Alexandria, and the results are of sufficient interest to demand review.

The Tebe is equipped with a triple expansion engine of 2,000 indicated horse power, steam being furnished by two double-ended cylindrical boilers, Howden's system of forced draft being used, with a steam pressure of 12.66 kilogrammes (180 pounds), and the tubes being fitted with retarders.

The tests were made with Texas petroleum supplied from Alexandria, the oil having a specific gravity of 0.931 at 15° C. and 0.905 at 55° C. Upon test this oil began to give off gas at a temperature of 91° C., and ignited at 110° C. It contained 1 per cent. of sulphur, and gave a residue of 0.021 per cent.

The equipment of the furnaces is of interest, since it involved but trifling changes from the arrangement for coal firing. The grates were removed from the corrugated furnaces, and the latter were lined with refractory material for a length of about one metre, there being also a contracted mouth or ring of fire clay fitted to the entrance of the furnace. The spraying nozzles, of which two were fitted to each fire door, were of the Körting style, pulverizing the oil by means of steam jets, and the petroleum was supplied under pressure from Worthington feed pumps, the oil feed pipes passing through a heater before reaching the pulverizers, so that the temperature of the fuel was raised to 80° to 90° C., this enabling it to pass readily through the filters placed in the nozzles. The oil was stored in the double bottom of the ship, from which it was drawn and delivered to feed tanks as required.

The plant was installed under the requirement that it should give an evaporation of 13 kilogrammes of water per kilogramme of combustible, under a steam pressure of 12.66 kilogrammes, with feed water at a temperature of 70° C. During the trials, however, an evaporation of 13,200 kilogrammes of water per hour was obtained with a consumption of 958.4 kilogrammes of oil, corresponding to a rate of evaporation of 13.77 kilogrammes. During the tests the temperature of the feed water was only 36° C. instead of 70°, and correcting for the additional heat thus required, the result corresponds to an evaporation of 14.55 kilogrammes of water per kilogramme of combustible, from 70° C. against a pressure of 12.66 kilogrammes.

These tests were supplemented by sea trials during the entire run from Genoa to Alexandria, the engines being run at full power, and the regular stops at Leghorn, Naples, and Messina being made. From the tabulated results given in the report the fuel consumption averaged 0.477 kilogrammes of petroleum per horse-power hour, or practically one pound per horse power; while the consumption of coal under identical conditions was never less than 0.68 kilogrammes, or about 1.5 pounds per horse power. Under both arrangements the air was supplied by the Howden apparatus, and the engine operated at about 11 expansions, at 84 revolutions per minute.

According to the report, the only difficulty which was experienced with the apparatus was the occasional obstruction of the filtering device forming a portion of the pulverizers. This obstruction appeared to consist, not so much of dirt in the petroleum, as of a carbonaceous deposit, probably formed by the action of the heat upon the oil. The formation of the deposit was indicated by the increased pressure necessary to deliver the oil to the burners, and it was found entirely practicable to clean the filter screens successively without interfering with the operation of the engines.

The results of these tests confirm fully the experience which has been had with liquid fuel in vessels elsewhere. No data are given as to the price of petroleum delivered at Alexandria, but so far as steaming value is concerned it appears to be fully confirmed that one pound of fuel oil is about equal to one-and-a-half pounds of good steam coal. In comparing costs the greater advantages in handling the oil should be considered, especially the difference between the convenient manipulation of the oil burners as compared with the laborious and brutalizing work of stoking coal furnaces at sea. The real question to be considered really appears to be that of fuel cost alone, and with definite data as to performance this element can readily be determined for any locality by comparing the relative local prices for coal and oil.

THE TESTING OF LOCOMOTIVES.

METHODS OF LABORATORY AND ROAD TESTS AND THEIR PRACTICAL APPLICATIONS TO DESIGN AND OPERATION.

W. F. M. Goss—American Society of Mechanical Engineers.

IT is now generally accepted that the true way to effect important improvements in any class of machinery is by means of careful scientific testing of existing machines, operated as nearly as possible under actual working conditions. The stationary steam engine is an excellent example of the development which results from an intelligent use of the results of careful testing, but in the case of the locomotive the conditions are not so favorable for the conduct of scientific trials. Road tests are made from time to time, but these are necessarily limited to the observation of such elements as can be measured while the machine is in motion. The actual resistance of grades, flange friction, and the like cannot be determined with that precision essential to accurate study, while the draw-bar pull, for example, requires a much closer determination than can be measured by any form of portable dynamometer.

In an important paper, presented before the joint meeting of the American Society of Mechanical Engineers and the Institution of Mechanical Engineers, recently held at Chicago, Professor W. F. M. Goss, himself closely identified with the development of the accurate testing of locomotives, discussed the growth of locomotive testing plants, from the early experiments of Borodin, in Russia, to the latest installation, that of the Pennsylvania Railroad Company, at the St. Louis exposition, this latter now being operated in the work of making comparative tests of a number of standard types of engines.

The early trials of M. Borodin consisted in arranging a locomotive engine to be operated temporarily as a stationary engine, by blocking the driving wheels up clear of the track, and allowing the power to be absorbed by driving shop machinery. This permitted the performance of the boiler to be studied, and also enabled indicator diagrams to be conveniently taken from the cylinders under conditions of determinate loading; and the work upon these tests, made in 1881 and 1882, demonstrated the economy of compounding and the advantages of jacketing.

Nearly ten years after the experiments of Borodin the first complete locomotive testing plant was erected at Purdue University, La Fayette, Indiana, under the supervision of Professor Goss, and from this plant, rebuilt after its destruction by fire, others have been developed, that at the St. Louis exposition being the latest and most complete.

"The Purdue plan for mounting a locomotive for experimental purposes involved supporting wheels carried by shafts running in fixed bearings, to receive the locomotive drivers and to turn with them; brakes which should have sufficient capacity to absorb continuously the maximum power of the locomotive, and which should be mounted on the shafts of the supporting wheels; and a traction dynamometer of such form as would serve to indicate the horizontal moving force and at the same time allow but a slight horizontal motion of the engine on the supporting wheels. Assume an engine, thus mounted, to be running in forward motion, the supporting wheels, the faces of which constitute the track, revolving freely in rolling contact with the drivers. The locomotive as a whole being at rest, the track under it (the tops of the supporting wheels) is forced to move backward. If now the supporting wheels be retarded in their motion, as, for example, by the action of friction brakes, the engine must as a result, tend to move off them. If they be stopped, the drivers must stop or slip. Whether the resistance to be overcome in turning the supporting wheels is great or small the force to overcome it is transmitted from the driver to the supporting wheel, and will reappear as a stress on the draw-bar, which alone holds the locomotive to its place upon the supporting wheels. The dynamometer constitutes the fixed point with which the draw-bar connects and serves to measure stresses transmitted. It is evident from these considerations that the tractive power of such a locomotive may be increased or diminished by simply varying the resistance against which the supporting wheels turn, and that the readings of the traction dynamometer will always serve as a basis for calculating work done at the draw-bar."

The friction brakes by which the power of the engine is absorbed are of the form designed by Professor Alden, consisting of a fixed case containing alternate fixed and moving discs, the case being filled with oil under pressure. The traction dynamometer, by means of which the draw-bar pull is measured, is based upon the principle of the Emery testing machine, this form being exceedingly sensitive and at the same time capable of resisting the tresses which are brought upon it.

"With reference to the results which have been obtained from the second Purdue plant during the ten years which have elapsed since its establishment in 1894, it is perhaps not too much to say that some of the facts concerning locomotive performance, which to-day are generally accepted, and hence quite commonplace, were first made known, or, if previously surmised, were confirmed by results obtained from this plant. The limitations affecting such simple factors as indicated horse-power and rates of combustion, are now commonly understood, but were much in doubt prior to the advent of the Purdue plant. It has shown that the American locomotive will, under favorable conditions, develop an indicated horse-power upon the consumption of from twenty-five to twenty-six pounds of steam per hour; a fact which ten years ago was accepted with expression of surprise. It has served to define the evaporative performance of the locomotive boiler. It has demonstrated, contrary to a belief once held, that steam delivered from the locomotive is practically dry. In the discussion concerning the advantage of controlling the output of power by means of the reverse-lever, rather than by the throttle, which was current ten years ago, a conspicuous part was given results obtained from the laboratory. It has shown that in a simple engine, the maximum cylinder performance results from a cut-off, which is between the limits of ½ and 1/3 stroke, and has demonstrated the whole relation of steam consumption to cut-off, under a considerable range of speeds.

Among the more specialized problems that were undertaken may be mentioned a study of the value of the steam pipes within the smoke-box when regarded as superheaters; the extent to which fuel loss is involved in the discharge of sparks from the stack, under different rates of combustion; the action of the steam-jet as a means of producing draught, and an investigation of the proportions which for maximum efficiency should be given the exhaust-pipes and stack."

As already indicated, the plant at the St. Louis exposition is identical in principle with that at Purdue, with the added refinements which have been developed in the 10 years of working experience. Especial facilities are provided for the reception of locomotives of various kinds, and the prompt adjustment of the operative parts to the variable conditions. Unusually complete devices for observing the results are provided; these including the accurate weighing of the coal and water, the recording of pressures, the observing of the quality of steam, of speeds, and of temperatures. An important feature of the tests is the provision of a staff sufficient to complete the computations for any engine, so that the results may be tabulated and available for comparison before the next run is made. This will enable the elements obtained for any engine to be kept in mind in the succeeding tests, and comparisons to be made during the runs.

In thus installing and operating a testing plant at an international exhibition, a single railway company may well be congratulated on having made a most valuable contribution to applied science, and in placing the supervision of the tests in the hands of such organizations as the American Society of Mechanical Engineers and the American Railway Master Mechanics' Association, the results will be given an authority beyond question or cavil.

SANITARY CONDITIONS AT PANAMA.

PRESENT AND FUTURE HEALTH CONDITIONS ON THE ISTHMUS IN CONNECTION WITH THE CONSTRUCTION OF THE PANAMA CANAL.

Dr. W. C. Gorgas—Engineering Record.

IT is generally admitted that one of the most serious problems to be contended with in the construction of the Panama canal is that of maintaining proper health conditions. During the construction of the Panama railroad and later at the time of the work of the French upon the canal, the losses by disease were very great, but there is every reason to believe that if the operative conditions are attacked in the light of modern science, the losses may be maintained at a minimum upon the new work now to be undertaken. For this reason the report of Dr. W. C. Gorgas, himself noted for the success with which he combated the malaria and yellow fever at Havana, is especially noteworthy. Dr. Gorgas went to Panama with the Isthmian Canal Commission, and his report to Admiral Walker has been published in a recent issue of the *Engineering Record,* from which we make some abstract and review.

"The Isthmus runs in a general direction from east to west, and the canal route generally from north to south. The town of Colon is the northern terminus of the canal, on the Caribbean Sea, and the town of Panama, the southern terminus, on the Pacific Ocean. The great chain of mountains which extends through North, Central and South America, has at this point, about its least elevation, the highest point of the divide through which the canal runs being here about 500 feet. The country is generally volcanic in its formation, thickly studded with numerous peaks and ridges, from 300 to 800 feet high, and should be described as being very hilly, and well drained.

"The canal, in general, follows the line of the Chagres river up to the divide at Culebra Cut, some ten or twelve miles from Panama, and from Culebra down to Panama, the valley of the Rio Grande river. These streams are not swampy in any sense of the term. The rivers mentioned above, of course, have a certain amount of low ground in their bottoms, but not more than a stream of the same size in northern New York. Owing to the warm climate and heavy rainfall, mosquitoes can find, all the year round, abundant places for breeding, even in as well-drained a section as the route of the Panama canal is.

"Colon is built upon a coral island in Limon Bay, the island itself being slightly below the main level of the sea. The part of this island on which Colon is situated is artificial ground, having been filled in three or four feet. The rest of the island is still covered with swamp. This is the only point at which swamps of any great extent would have to be dealt with."

Dr. Gorgas states that he considers the canal strip in the normal state for tropical regions, from a health point of view. That is to say, the death rate would be about fifty per thousand, very high for northern climates, but not excessive for the tropics. At the present time there are about 40,000 persons on the strip, there being 20,000 at Panama, 3,000 at Colon, and 15,000 in the little towns along the route. If we gain our ideas from the death records during the construction of the Panama railroad or the French work on the canal, we must consider the locality as most unhealthful. If, however, we view the question in the light of modern knowledge and methods, we may see good reason for a modification of this view.

According to Dr. Gorgas, the principal disease to be overcome is malaria. There is a certain amount of yellow fever, which may be eliminated by the same methods which have proved successful at Havana, but the chief danger is from malaria, and if the malaria is not controlled the mortality will be very great.

According to the investigations of Dr. Gorgas, the chief danger from malaria lies in the infection of the unacclimated white men from the malarial natives through the mosquito. Nearly all the negro inhabitants of the local villages are victims of chronic malarial infection, and the presence of the poison-bearing mosquito, or anopheles, renders it practically certain that the imported laborers will be infected, if some means are not taken to prevent it. Such preventive measures are entirely possible, as Dr. Gorgas shows:

"What I propose, is to take each village, put it under a systematic scheme of inspection whereby we shall be able to control all water barrels and deposits of water, so that no mosquitoes will be allowed to breed, look after its street cleaning and disposal of night soil, etc., so as to get it in good sanitary condition, then have the population examined and recorded, so that we shall have on a card a short history of each individual, and keep track of them in this way. Those suffering from malaria will be put under treatment, and watched as long as the malarial parasite is found in the blood. I hope, in this way, to decrease to the smallest limit the number of anopheles, the malarial-bearing mosquito, and, at the same time, to gradually eliminate the human being as a source of infection, so that at the end of a year it will be entirely safe for an unacclimated man to live in any village."

So far as yellow fever is concerned, its prevention will depend principally upon the sanitary work which is done at Colon and at Panama, and the quarantine arrangements for preventing its introduction. This problem is not greatly different from that at Havana, and there should be no difficulty about carrying these out on both sides of the Isthmus.

Dr. Gorgas speaks plainly about the extreme views on both sides which are heard upon this important subject, as he says:

"I hear two opinions expressed with regard to the health of Panama. The general opinion, that one sees in the papers, is that it is almost fatal to live there, people expressing this opinion thinking that the conditions there now are exactly the same as when the French had fifteen or twenty thousand laborers on the work, and were losing by death and sickness a considerable proportion of this force every year. This is, of course, not true. The health conditions of Panama, at present, are not a bit worse than those of most other tropical countries. On the other hand, particularly down at Panama, you hear men talk as if it were a health resort. This is not so. The death rate now is large, as I said before, about like that of most tropical countries, and unless we can change conditions within the next year it will be far from a health resort, when our large force of laborers are on the ground and the work is in full swing. I recently saw an engineer, who had been on the ground for some time and was a man of considerable experience, quoted as saying that both the engineering and sanitary problems were simple and could be easily solved.

Of the engineering problems I am no judge, but such statements with regard to the sanitary problems, by men of position and experience, I think are very rash and tend to do harm. In my opinion, the sanitary problems are grave. The question of eliminating yellow fever from an endemic focus has only been once before successfully managed, and that was to Havana. And, from this successful work, to argue that it is easy and simple, I think is not warranted. The malarial work, on the scale at Panama, is entirely new. It has never been attempted elsewhere, and any health officer, who has had any experience in enforcing measures of individual prophylaxis, such as will be required at Panama, can understand how great the difficulties of administration will be. Personally, I believe it can be done, and I approach the work with great hope of success, but I know that it will be neither easy nor simple, that we will meet with many disappointments and have to modify our plans many times."

THE IRON AND STEEL INDUSTRIES OF THE WORLD.

A STUDY OF THE STATISTICS OF MANUFACTURE, EXPORTS, AND IMPORTS IN CONNECTION WITH THE INDUSTRIAL POSITION OF GREAT BRITAIN.

William Pollard Digby—Society of Arts.

WHATEVER may be the outcome of the present agitation in Great Britain with regard to the much discussed fiscal question, there is no doubt that it has been, and will doubtless continue to be the cause of the study of a number of most important elements which go to make up the manufactures and commerce of the Empire. Among such investigations we may note an important paper examining the statistics of the iron and steel industries of the world, recently presented by Mr. William Pollard Digby before the Society of Arts, and published in the *Journal* of the society.

Mr. Digby examines the subject from three separate points: that of the supplies of ore and the production of pig iron in the United Kingdom, as compared with Germany and with the United States; that of the relations of the import and export trade of Great Britain to the external trade of other countries; and that of the margin of profit of the iron industries reckoned on the external trade alone of the leading iron-producing countries.

"A complete survey of so vast an undertaking as the British iron trade, with its many ramifications, its complex questions, might well appal a Royal Commission, while an extension of the survey to the dissection of the exact situation in regard to every branch of the iron and steel industries of the United States and Germany would occupy a special International Commission for an indefinite period.

"The difficulty likewise hinges upon the question of internal consumption, of what proportion the home market bears in each case to the country's export trade, and as to how far the imports from other countries affect the home market. The relation of the import and export trades to each other is easily defined, and the chief sections of the import and export trade receive separate enumeration in the various Government returns. While it is possible to define the value, say, of steel rails, respectively imported and exported from the United Kingdom, we do not know the total production of the value of steel rails used in any year by the different railway companies and tramway undertakings within the kingdom. Again, it is possible to give the value in any year of the locomotives sent to foreign countries and to our own Colonies, and it is not difficult to enumerate the sporadic dumpings of locomotives into England on those occasions when lack of foresight had allowed the number of engines under construction to fall below immediate requirements, so that occasional purchases from America resulted. We can, in this latter case, go a step further and give the number of locomotives included in the rolling stock for any one year. But we cannot give the amount of the expenditure in any year on new locomotives either for our railways or for the rough lines laid by contractors for their dock, or reservoir, or railway, constructional work.

"Similarly, if we regard shipping, while returns have of recent years been published giving the values of our sales of new ships built for foreign countries, we have no return of the value of the yearly additions to our mercantile marine, or of the value of the plates, rivets, or stern-frames which, forming the raw material for the shipyard, are nevertheless the finished product of the steel merchant. We are also without returns as to the value of the iron and steel supplied to the ship's engine builders wherein 'the purring dynamos,' the towering five-crank reciprocating engines, the compact turbines, the belauded Scotch and belittled Belleville boilers, find their raw material.

"Turning to the textile of electric cable factories of Lancashire of the paper mills of Thames valley, no returns tell of the proportion of foreign machinery therein installed or of the extent to which the manufacturers of their myriad engines, boilers, looms, brading machines, potchers, shafting, or pulleys, have indented directly on foreign or on British machine makers, or have purchased high-class machinery, itself in part made from raw iron or raw steel produced, perchance, in a foreign country."

Taking up first the question of the production of iron ore and pig iron, the statistics of Great Britain, Germany, and the United States are shown by curves covering the past thirty years. Broadly these show a gradual fall in British production of ore as against an increasing British consumption. Both Germany and the United States have been developing their own local deposits, although both England and Germany are obliged to look abroad for the raw material for their furnaces. It is this question of the necessity of importing iron ore which has, in the minds of many, placed Great Britain at a great disadvantage, but Mr. Digby calls attention to the fact that the inflow of ore, essential to the existence of British iron furnaces, supplies also income on British investments.

"Ore beds in northern Spain have been purchased, railways built, and machinery supplied. Steamship services have been organized, blast furnaces erected on the seaboard, so that in some cases the ore is carried with only two handlings from the ship's hold to the furnace mouth. Those who talk loudly of the extinction of the iron industry have not recked of the manner in which the iron industry has called, not in vain, on the country's capital to provide other sources of raw material."

In this respect the position of England is not unlike that of the Pittsburg district in the United States; the supply of ore brought by the lake steamers having developed the iron-making industry on the shores of the Great Lakes. There is this difference, however, that in the United States the supply of ore may and does lie in other States of the Union, but not without the boundaries of the nation, or in another country.

Taking up the question of the export and import trade of the several countries, some interesting features are brought out. These also are plotted in diagrams, showing that, while British export trade has suffered fluctuations, it has, on the whole, exhibited a steady rise, and furthermore, has shown a corresponding proportion of profit. It is with the margin of profit between exports and imports with which Mr. Digby concerns himself, and in this respect he takes an interesting view of the question, computing the relative value of the profit measured in food. For this purpose he makes use of Sauerbeck's index values for food for the corresponding periods. Upon this basis it appears that the maximum of profit was not in the early seventies, the era which has been so often cited as the zenith of free trade prosperity, but between 1888 and 1892. It may be advanced that while the coefficient of food profit has advanced the population of the country has advanced at an even greater rate. This, however, is considered by taking the profits per head of population, which has some interesting features.

Mr. Digby takes the period from 1868 to 1902, divided into quinquennial periods, and from his figures it appears that during that period the profits per head of population have fallen off to about one-half that which obtained at the beginning. At the same time the profit margin per head of population in the United Kingdom still stands at about threefold that recorded for either the United States or Germany. These latter countries, however, show an increasing rate, the United States a rapid one, Germany more slowly.

A strong plea is made by Mr. Digby for

more complete statistics of internal trade.

"Whether our studies of industrial economics will on one hand continue to be as full and as complete as the wit of man and the Board of Trade returns can make them, or on the other hand be limited to surmises based on the condition of the external trade (simply and solely because we have no records of the quantities and values of our manufactures which are internally consumed) rests with the manufacturers of this country. Any person can prate of exports and imports, but who can speak even in regard to iron, of the employment given to thousands of artisans making looms for Lancashire, locomotives and rails for our railways, dynamos and arc lamps for our street lighting, steel girders and angle iron for our large buildings? Or, again, as regards the value of the shipping added each year to our mercantile marine; while it would not pass the wit of Dr. Ginsburg to estimate the capitalised value of the shipping on Lloyd's Register, even he might fight shy of estimating the apportionment of the expenditure of a single year's increase among the many industries whose concerted efforts have fed the ship builder. Yet large quantities of our food imports are paid for by new ships made to foreign order, other quantities of food are paid for by old ships sold for a few more years of life or to be broken up, while still other quantities of the imports which enter the country are the earnings of ships carrying the red ensign and launched in the preceding year.

"A great volume of our iron must surely go into what, for varying reasons, are investments which are directly or indirectly remunerative, railways, shipping, locomotives, lathes, looms, or other machinery; even the hammer and cold chisel are not unproductive directions either for home manufactures or imports.

"'Among the blind, the one-eyed is King.' What shall we say of John Bull, who is not even equipped with half his powers of vision when considering his own entire commerce? External commerce is clearly displayed in export and import returns. Internal commerce is practically shut off from his vision. Its fruits, so far as percentage of pauperism or saving banks returns are concerned, can be gauged any day. But the full extent of the effects of 'dumping' can only be truly known when manufacturers will consent to a dissection of the statistics, not only of the trade of manufacturer A whose finished article is threatened by foreign competition, but also by a dissection of the trade of manufacturer B whose raw material is often the finished product of manufacturer A.

"At a time when ill-digested statistics are thrown to and fro in argument, a plea for more statistics sounds impertinent. Yet some measure of the relation of imports not alone to exports, but to home consumption also, is surely necessary before we talk of doomed industries. Will none cease from a strife of the rival panaceas—protection, altered business methods, temperance, retaliation, education, free labour, bounties, and so forth (good though some of these may be) and unite to obtain the true figures of internal trade and its relation to exports and imports? For, only when these have been obtained are the component parts available with which alone it is possible to paint the only veracious picture of the nation's true condition."

HIGH-SPEED STEAM LOCOMOTIVES.

DESIGNS FOR STEAM LOCOMOTIVES FOR COMPETITION AGAINST HIGH-SPEED ELECTRIC TRACTION.

Glasers Annalen für Gewerbe und Bauwesen.

As a result of the high speeds attained by the electric cars on the Marienfelde-Zossen military railway the locomotive builders of Germany have become aroused, and in consequence the *Verein Deutscher Maschinen Ingenieure* arranged a competition for the best designs for high-speed steam locomotives. From among the plans submitted there have been five selected as superior to all the others and in a recent issue of *Glasers Annalen* these designs are compared by Herr W. Wolters, the several locomotives being fully shown by drawings. These engines have been designed for continuous running speeds of 120 to 150 kilometres per hour, or 74.6 to 93.2 miles per hour.

It is impracticable to give in this place any complete description of the several designs which have been thought worthy of award in this competition, but some general examination of the elements which have been assumed by the designers to be essential in producing a high-speed machine may prove interesting.

In the first place compounding has been adopted by all the competitors, four out of the five machines being of the four-cylinder balanced variety, and the fifth having three cylinders. This latter machine is peculiar in that it has the three cylinders of the same diameter, the single inside cylinder being the high-pressure one, this exhausting to the two outside cylinders, giving a ratio of two to one. In the case of the four-cylinder compounds the ratio ranges from 2.4 to 3 to 1. In weight the engines range from 75 to 95 tons, the power running from 1,000 to about 1,350 horse power. With but one exception the engines are intended to be operated at a boiler pressure of 14 metric atmospheres, or 200 pounds per square inch, one of the four-cylinder compounds being planned for 15 atmospheres, or about 227 pounds per square inch pressure.

The general inspection of the plans shows that the various designers have attempted to insure a sufficient supply of steam by using it with the highest economy. Thus three of the designs include superheaters, while the two remaining machines have a greater amount of heating surface in the boilers, doubtless to provide a necessary additional steaming power. Nearly all the plans appear to have made some attempt at minimizing the wind resistance by encasing the entire machine in a casing with wedge-shaped prow and smooth sides and top, although it is probable that this plan offers a greater area for the action of lateral wind pressures in crowding the flanges against the rails, than with the ordinary uncased machine.

One of the most interesting features about the various competing designs appears in the efforts which have been made to reverse the usual arrangement of things and place the engineer in the front of the whole machine, thus giving him the same advantage as regards position as is occupied by the motorman of an electric car. There is no real reason why a locomotive should ever have been arranged to run with the smoke stack in front, and the engineer craning his neck around to obtain a view of the track, and it is a matter for surprise that designers should have waited as long as they have to place things in their correct position. Some of the engines submitted in the competition show a reluctance on the part of their designers to remove the smoke stack from its time-honored place in front, and place the engineer in the front of the machine and the fireman behind, thus separating two men who should be always in close relation to each other. Herr Richard Avenmarg, of Munich, alone has the courage of his convictions, and boldly turns the whole machine around and places the engineer and fireman in a commodious cab in the very front of the engine, and relegates the smoke stack to the rear, thus giving an uninterrupted view of the track, free from smoke and cinders, regardless of the opinions of more conservative members of the fraternity.

Since these various designs exist at present entirely upon paper, it is too soon to pass upon their merits in detail; it will be time enough for that when they have been built and given actual trial. At the same time the speeds which they are expected to attain are not higher than have been successfully reached by locomotives of existing designs, so that even if they succeed in attaining the ends of their designers they will have performed nothing very notable. Indeed, it has been realized for some time that the present limit to locomotive speed is not that of engine construction, but rather that of the provision of solid, rectilinear, uninterrupted roadway. After the track shall have been made perfectly ready, with perfect alignment, and massive rails, and existing forms of locomotives shall have shown their inability to make the speeds which this competition demands, it will be ample time for builders to exert themselves to produce new designs, which will themselves, in turn, demand still further improvements in the track upon which they are to run.

MODERN STEAM ENGINE TESTING.

THE EQUIPMENT, OPERATION, AND IMPORTANCE OF THE TEST HOUSE OF A MODERN ENGINE WORKS.

R. K. Morcom—Institution of Electrical Engineers.

NOT so very many years ago the subject of testing steam engines was considered to be a matter entirely within the province of the specialist, and when a test was to be made the consulting engineer and his staff appeared in the room where the machine was already installed and went through the elaborate performance with the aid of such portable appliances as they could bring with them.

Such tests are even now made upon large engines, especially if the determination of the fulfilment of certain contract requirements must be made, but there is another side to the subject of steam-engine testing, about which not so much has been written, and concerning which an interesting paper has been presented before the Birmingham Local Section of the Institution of Electrical Engineers by Mr. R. K. Morcom. This portion of engine testing relates to the critical trials to which engines are subjected by their builders before delivery to the purchaser, such trials usually being conducted in a special test house constructed for the purpose. Mr. Morcom's paper discusses mainly the equipment of such a test house, and the practical methods of operation. As he well says:

"The days of broad guarantees of coal consumption of a plant per month or per annum have now passed, and the era of the specialized testing has been inaugurated by modern competition. Nowadays boilers, engines, generators, and motors must all be proved to fulfill the specification as to efficiency and reliability, and it is on the closeness with which the results obtained approach the guaranteed figures that the justification of an enterprise often depends.

"The value of the experience gained by tests is so great that all progressive manufacturers lay down more or less extensive testing plants for their own use, and so it is only natural that their test houses should also be used to demonstrate guarantees, and so insure that time shall not be wasted on site, and to avoid the inconvenience to a station engineer of having his station turned into an experimental testing department."

The plant described by Mr. Morcom is intended to receive units ranging in size from 75 to 1,250 horse-power, running either condensing or non-condensing, with steam pressures from 80 to 250 pounds per square inch, and from saturation up to 350° F. superheat.

The electrical requirements include currents from 10 to 2,000 amperes with voltages from 60 to 6,000, either continuous or alternating, of various frequencies.

Such a plant demands a high degree of flexibility, especially as the elements to be measured include temperatures, pressures, volumes of steam, water and air, mechanical and electrical energy, fuel composition and calorific value, gas analysis, etc. Facilities must also be provided for the investigation of the performance of mechanical details, such as the action of governors, lubricators, packings, gauges, and the like, so that the judgment with which the whole is arranged must have an important influence upon the convenience of operation. The detailed arrangement of the particular plant described by Mr. Morcom is therefore not of so much importance as an examination of its elements, since every such installation must be arranged to meet the especial conditions involved.

Steam should be provided by several independent boilers, so that tests at different pressures may be conducted simultaneously; pressure-reducing valves not having been found satisfactory. A separately-fired superheater is desirable, as giving greater control over the conditions of superheat, and facilities for weighing coal, measuring feed water, and drawing off reliable samples of flue gases for analysis, should be provided. All pipes should be lagged, and it has been found that asbestos rope of large diameter forms a convenient material for covering temporary pipe connections.

The use of mercury cups, inserted into pipes to enable thermometers to be employed in taking temperatures, has been found to lead to errors. The mercury-pressure pyrometer has been tried, this instrument operating by the pressure of expanding mercury acting against a steel spring, and indicating upon a dial face with a needle. Mr. Morcom states that he has obtained satisfactory results by using a thin steel tube, screwed well into the steam pipe through a stuffing box, so that an asbestos packing may insulate it from the steam pipe, oil being used in the pipe instead of mercury as being more accurate and less liable to boil away at high temperatures.

Provision should be made for the reception and condensation of the entire exhaust steam from an engine under test, this providing the most accurate method of determining the steam consumption, and also being necessary for the operation of condensing engines. In the plant described by Mr. Morcom there are three surface condensers, so arranged as to be connected up as may be required, there being also an atmospheric exhaust main. The air pump discharge can be delivered into tanks attached to balances with electric annunciators, and every facility provided for the detection of leakages.

The loads placed upon engines under tests may be either mechanical or electrical, and when no dynamo is available power-absorbing brakes of the Heenan and Froude type may be used to advantage. Especial facilities for using the indicator upon the engines should be provided, and for machines with high rotative speed great care is demanded, both as to the accuracy of the instruments and to the methods of their connection, to insure reliable results.

The selection of electrical instruments must naturally depend upon the nature of the machines to which they are to be applied, and not a little also upon the predilections of the observer. There a number of standard makes which are acceptable to the profession, and these and the switchboard may readily be arranged so as to correspond closely to the actual equipment of a working station.

Since the resistances by which the electric current is absorbed form an important portion of a testing plant, the experience of Mr. Morcom in this respect may be found of value.

"After considerable trouble and expense in connection with wire resistances, both in wooden and iron frames, a form of water resistance for taking up the load has been devised. The poles are of iron, arranged in wooden tanks. Water from a neighboring canal is passed continually through the tanks by a by-pass on the condenser circulating pump, and flows out over a weir. The poles are connected to a load-adjusting switchboard, and can be coupled into the load in many combinations. Three tanks are used for different ranges of voltages, and these ranges are further divided by adjustments of the outflow from the tank. Specially subdivided tanks are used for polyphase work.

"The first experience when using a water resistance was not very satisfactory. The apparatus consisted of an iron tank about 3 ft. wide and 6 ft. long, with two large iron plates for the electrodes. This tank did not last very long, for the current, as well as passing from plate to plate, found a shorter passage by way of the sides and bottom of the tank. An improvement of this arrangement was a large wooden tank, 4 ft. wide by 10 ft. long, and about 4 ft. deep. Into this were fitted four hollow cone-shape castings, large end upwards. Inside each of these cones was a smaller one, suspended from above on a screwed spindle and hand-wheel. The outer cone was coupled to one terminal of the dynamo on test, and the inner through a flexible lead to the other terminal. Load could then be varied by raising or lowering the inner cone on the screwed spindle. It was necessary to keep the water-level a little higher than the top edge of the outer cone, so that the heated water in the space between the cones might rise naturally and flow away. This arrangement gave very satisfactory results; in fact, some cones are still in use which were fitted about eighteen months ago.

"For higher voltages it was proposed to use a metal rod dipping into the water at the centre of the cone; but the conducting area of water to the outer cone was too large, and the length of water resistance too small, for many machines. Accordingly, a wooden trough of small cross-section and great length was designed for high-voltage work.

"The use of wooden troughs did away with the need for conical poles, and it is now found more useful to substitute iron plates fixed at the top to flexible terminals, and movable on insulated rollers along wooden runners. The load can thus be varied by sliding the plates along so that the cross-section between them is varied. By using a considerable number of small plates a very flexible load is obtained, and if care be taken with the circulating arrangements, a very steady load results."

The conduct of the work of such a test house demands experience and reliability, and the plant should be placed in the hands of an able and interested chief, with such assistance as he may deem necessary. It should not be regarded as a sort of scientific luxury, but rather as the completing process in the construction of both engine and dynamo, since such tests are principally made upon direct-connected generating sets. With such a department the manufacturer obtains a positive knowledge of the character of his work which gives him a confidence not otherwise attainable, while in many cases information is obtained which leads to important improvements.

"A testing-department is always accumulating results, and every result is entered up in careful history books, anomalous figures are remarked on, and, if possible, explained, and curves illustrating various points are frequently made. This mass of information is necessarily largely unpublished, and the public only hear of the work of those numerous well-equipped laboratories when some improvement is put before them in a fully-fledged condition. Probably much of the information is not used in the full, and doubtless there are many experiments made in engineering colleges and institutions to elucidate mysteries, when all the time the solution is lying clear to see in some manufacturer's record book."

THE RESISTANCE OF METALS TO CUTTING.

DYNAMOMETRIC MEASUREMENTS OF THE FORCES INVOLVED IN THE CUTTING OF METALS IN THE LATHE.

Dr. J. T. Nicolson—Institution of Mechanical Engineers.

SEVERAL months ago we reviewed in these columns the exhaustive experiments conducted by Dr. Nicolson at Manchester upon the performance of rapid-cutting tools steels, and now we have, in a paper presented at the Chicago meeting of the Institution of Mechanical Engineers an interesting account of the ingenious form of lathe-tool dynamometer designed and used by him in investigating the forces acting upon a cutting tool.

The object of such an apparatus will at once appear from Dr. Nicolson's account of the conditions which led to its design.

"In the tool-steel trials made by the Manchester Committee in 1902-3 (the report upon which was published by the Manchester Association of Engineers in their Transactions for 1903), there appeared an entire lack of uniformity in the shapes and angles of the tools submitted by the eight competing firms. There was also no obvious connection between the shapes and angles of the tools and the cutting forces upon these tools deduced in the report from the electrical power measurements made by the Committee. Neither did the shape or angle supply a clue to the causes of success and failure in the various trials with different tools.

"On the other hand, the necessary reconsideration of the design of lathes for the rapid and heavy cutting rendered possible by the new steels introduced by Taylor and White, and now everywhere adopted, calls for a thorough and systematic investigation of the forces acting upon a cutting tool. If a standard area of cut can be agreed upon for the various sizes of lathe, a knowledge of the forces to be overcome when taking that cut,—not only for turning the work against the tool, but also for moving the slide-rest and saddle in both the traversing and surfacing directions—will enable the calculation of the stresses in, and the proportioning of, the various parts of the machine to be gone about in a rational and scientific way.

"No such knowledge has hitherto been available; and it appeared to the author that the prosecution of a somewhat extensive research into the matter would well repay the time, labour, and expense, which it would necessarily involve."

In reviewing the work of previous experimenters in this field Dr. Nicolson refers to the work of Hartig, who enunciated the law that the cutting force varies in simple proportion to the depth of the shaving; also to the investigations of Mr. Mallock, in the engineering workshop at Cambridge University. The experiments of Professor R. H. Smith are also briefly discussed, and the defective features of his apparatus pointed out. No mention is made, however, of the exhaustive researches of M. Codron upon all kinds of cutting operations, although these have been published in full in the *Bulletin de la Société d'Encouragement pour l'Industrie Nationale.* The researches of Codron, however, do not include the new high-speed steels, and so are of comparative value only, although they have thrown much light upon the true nature of all metal-cutting operations.

The detailed construction of the dynamometer of Professor Nicolson is fully given in his paper. In general it consists of an attachment to the tool holder and the slide rest, composed of hydraulic supports connected to Bourdon pressure gauges. The first form of dynamometer was arranged to measure only the vertical forces acting upon the point of the tool, while the second apparatus was constructed to measure not only the vertically directed force, but also that tending to push the tool and saddle backwards, and that tending to oppose the traversing feed. The apparatus was designed to permit pressure as high as 15 tons to be observed, and pressure of 10 tons were actually measured during the trials.

In conducting the tests it was necessary to assume certain trial forms and angles of tools. The first trials were made with tools having the cutting edge horizontal, and at an angle in plan of 45° with the axis of the work. The top surface of the tool was a plane containing the cutting edge, and inclined at the angle called "the cutting angle" to the vertical plane, which also contained the cutting edge. The cutting edge terminated at a point ⅜ inch from the right-hand corner of the tool (in 1¼ inch square tools) so that the average cut taken would give a downward thrust, acting as nearly as could be arranged in the centre line of the tool, so as to prevent any twisting action and undue load upon the steel centre points. The nose of the tool had a clearance angle in plan of not less than 1°, and a small radius was ground on the corner between the two edges. The front clearance was 6°, the tools being used with the cutting edge on the level of the centre of the work.

Tests were made upon case iron and upon steel with this form of tool, and also with tools set to the angles of 60°, 75°, and 90°, with feeds of 1/16, ⅛, ¼, and ⅜ inch, and with depths of cut of ⅛, ¼, ⅜, and ½ inch, the results being fully tabulated in the paper. Broadly the conclusions drawn are: for a given traverse the cutting force is simply proportional to the depth of cut; the cutting stress being constant for a given width of traverse and given tool angle. The cutting stress varied widely with the cutting angle, being a minimum for an angle of about 60°, although this is not the angle of greatest durability. A cutting angle of 80° appears to be the best adapted for shop use, the cutting stress for this angle being about 75 tons per square inch. The variation of cutting stress with traverse is somewhat complicated. For keen cutting angles, below 75°, fine traverses require less cutting force than wide ones, while for bluntnose tools the reverse is the case.

In general it appears that the ordinary shop tool, when cutting soft steel, exerts a vertical force of about 100 tons per square inch of area of cut removed, irrespective of the proportion of width of traverse to depth of cut.

"All the trials were made in the endeavour to determine the laws of the variation of *cutting force* with tool-angle and with shape of cut. It was, however, not *à priori* to be expected that the tool-angle which gave the smallest cutting force would also prove the most durable or remove the greatest weight of material before failure. As this is a point of even greater practical importance than the other, two further series of trials were projected, one on the soft steel, the other with the medium cast iron, for the purpose of finding the cutting angle to be commended for shop use.

"In the cast-iron series a cutting speed of 44 feet per minute, with a cut 3/16 inch deep by 1/16 inch traverse, was decided upon, after about fifteen preliminary trials had been made. It was found in these preliminary experiments that a foot per minute, more or less, in the cutting speed made a great difference in the duration of the experiment; and, as time and material had to be economised, the careful adjustment of the speed was necessary to ensure uniform and consistent results. Cutting angles of less than 60° were excluded, but it was decided to use tools of 60°, 65°, 70°, 75°, 80°, 85° and 90° cutting angles, and to run them at the above speed *exactly* until they failed."

The results of these endurance tests showed that for maximum endurance in cutting cast iron the tool should be ground so that the true cutting angle is about 81°; or if an angle of 6° for clearance be allowed, there will be an included angle of 75°. For steel a cutting angle of about 70° or an included angle of 65° appeared to last the longest for rapid cutting.

For the details of these and a number of other tests the reader must be referred to the original paper, but these general conclusions will be of special interest. The whole investigation leads to a confirmation of the points now being generally made in modern works management, and discussed in the articles by Mr. Ashford and Mr. Day elsewhere in this issue; namely, that the choice of the form and position of the tools should not be left to the unaided judgment of the workman, but should be determined according to scientific principles and experiment, and prepared by special mechanics in the tool room, leaving the duty of the machinist at the lathe, planer, or other machine to the use of the tools which have thus been prepared for him.

The importance of the experiments of Dr. Nicolson to the designer of machine tools need not be emphasised, since it is evident that they furnish him with data hitherto entirely lacking.

FIRES ON SHIPBOARD.

CONSTRUCTIONAL SAFEGUARDS AND METHODS OF FIRE PREVENTION AND EXTINCTION ON BOARD SHIP.

E. O. Sachs—Institution of Naval Architecture.

IN view of the recent disasters on vessels in various parts of the world the paper of Mr. Edwin O. Sachs, upon the prevention of fires on shipboard, presented before the Institution of Naval Architects is most important and timely. Mr. Sachs truly says that the subject has by no means received the attention which it demands, and in this respect there are few who will disagree with him, and those few will doubtless be those who permit their financial interests to overpower their better instincts of humanity and justice.

Since his experience has been almost altogether upon land, Mr. Sachs states that he considers a ship much as he would upon a building, but it must not be forgotten that a vessel at sea is much further removed from external aid than a building in a city. At the same time anything which will help to insist that all vessels shall be made practically fireproof demands consideration.

"In respect to the safeguards that call for consideration in these three classes of tonnage, they may be divided—as on shore—into (*a*) constructional safeguards, (*b*) safeguards in equipment, (*c*) administrative safeguards, and (*d*) safeguards in fire extinguishing. All these forms of safeguard should be applied to our shipping, each class of safeguard varying in importance for the individual class of tonnage.

"Regarding the constructional safeguards, the primary safeguard in design may be considered to be the one which is now being generally adopted on land, namely, that of dividing the ship into a maximum number of fire-resisting compartments, and this division, for the purpose of reducing possible fire risks, must be more extensive than that of the compartment system already in general use for the purpose of dividing the ship into water-tight compartments. It will be found easier to divide the ship into fire compartments that may be deemed individual fire risks, rather than into the water-tight compartments generally associated with shipbuilding designs. The divisional lines of the water-tight compartments will necessarily serve as a basis for the fire-resisting compartments, but the latter should be more numerous. The horizontal division of a fire-resisting character does not bring with it any technical difficulties. The subdivision of the hold into smaller compartments than the subdivisions we generally know of is of little difficulty and inconvenience to the majority of cases. Having special regard to the passenger boat, there is not the slightest reason why the long flights of cabins and saloons should not have a more frequent subdivision than what is usually found in the subdivisions by water-tight doors. The primary safeguard against spread of fire in all ships of all classes will be their division into the largest number of small fire risks practicable with the work of the ship; and this number can and should far exceed the number of divisions made in order to obtain water-tight compartments.

Turning next to the safeguards in the application of materials in the construction of vessels, I consider the reduction of combustible material to a practical minimum to be an essential. For the passenger ship, however, in particular, the reduction of the combustible material should be compulsory; and, above all, the vast quantities of highly inflammable wood partitioning and fitments used on board our ocean greyhounds should be absolutely condemned. There is not the slightest reason why wood should be used at all to the extent it is at present, for with metal framing and the various forms of non-conductive sheeting of a non-inflammable character, the component parts of which are, to a considerable extent, asbestos, a very considerable amount of the woodwork could, *ipso facto,* be banished, to the advantage of all concerned; for these sheetings economise space, and are excellent non-conductors where climatic changes are encountered."

Mr. Sachs discusses at length the use of wood which has been rendered non-inflammable by chemical treatment, and maintains that he is of opinion that the non-inflammability of wood is a matter which has been solved commercially.

"Regarding safeguards and equipment, the two forms of equipment in respect to which a great deal more attention should be paid are the protection of the hot steam piping and careful electric wiring.

"Regarding the hot steam pipe, its protection in many instances is quite insufficient, particularly on the cheaper class of boat—*i. e.,* the minor passenger boat and the minor cargo boat. The result is that the hot steam pipe is frequently the cause of outbreaks of fire, afterwards attributed to spontaneous combustion or climatic conditions. The steam pipe should have additional protective covering beyond its ordinary isolation covering, in the form of a wire guard in all exposed places, so that anything lying right up against it does not touch the pipe or pipe coating—*i. e.,* there is an air space intervening."

The electrical risk is mainly one of neglect and might be made a minor matter by the insistence of proper supervision and inspection.

In regard to the important question of administrative safeguards, Mr. Sachs maintains that these are by no means as complete as they should be from the fire point of view. There is no reason why structures afloat should not be provided with fire patrols, in a manner similar to that which has been accepted as essential for buildings on land, and in connection with mechanical recording appliances and regular inspection, be considered as a part of the regular equipment. Strict rules should always be formulated and kept especially in connection with crowded steerages and similar conditions. Since this is especially difficult with excursion vessels and boats in which the passengers travel for short periods of time, the importance of extra patrol service for such occasions will be understood.

The necessity for the provision of adequate appliances for the extinguishing of fire will be admitted by all, yet, as Mr. Sachs remarks, there is not much to be said in favor of the fire service equipment on board ship.

"For the ordinary small fire on board ship, nothing is more in place or more effective than the ordinary bucket and hand-pump. The next thing which should be remembered is, that a hydrant, to be effective on board ship, must stand charged at a fair pressure of, say, two atmospheres, and be so placed that it can be immediately brought into action. Pumping water at high pressure is not of such importance during the first few minutes as an efficient stream at a fair pressure, immediately applied without fuss or trouble.

"Steam-pumps will, of course, be found ready for action on any decent ship nowadays, but really strong and efficient manuals should be placed in positions where a large number of men can easily get at them and efficiently handle them. These would be reliable stand-bys. The inefficient squirty manual of an antiquated type is all too common. Attention should be paid to matters of detail, such as good either-end couplings and good hose. In all ships the hand-pump and hydrant should be accorded premier importance.

"On the cargo boat, however, and on the combined boat, the fire-extinguishing equipments should compulsorily include an extinguishing plant for the application of carbonic acid gas, or some other form of gas. This form of extinguishing is most effective, but it must not, of course, be considered to entirely replace extinguishing by water."

Naturally there will be objection made, on the score of expense, to the proper equipment of vessels with adequate and suitable fire extinguishing appliances. This is the selfish point of view of the owner, but owners are apt to be selfish when the expenditure of money is involved, and Mr. Sachs does not attempt to relieve them from this imputation. On the contrary, he assumes that it is only by showing them that their pockets will not be very severely touched, apparently, that he hopes to gain their attention.

"Even if there be some additional capital outlay in the first instance, the loss of interest thereby involved should be partly made up by a reduction on the underwriting rates, both as to the ship and its cargo. The additional division into compartments is not a great expense. The application of non-inflammable materials, though at first sight an apparently heavy item, involves but a very small percentage on the total expenditure of furnishings and fitments in an up-to-date passenger ship. The expense for the administrative safeguards is minimal, and that for the fire extinguishing equipment likewise. In fact, if only shipowners and shipbuilders would take the matter to heart, they would find that the moment they really wished to make their vessels safer from fire, they would be able to do so at a very small cost; whilst, of course, as long as they look upon the safeguards with disfavour, the extra expense will be described as enormous."

In concluding his paper Mr. Sachs gives a list of vessels injured by fire during the year 1903, and calls attention to the fact that in many cases the report of ships as "missing" has doubtless been due to disaster by fire or which no other record has ever been obtained."

MUNICIPAL TRANSPORT PROBLEMS.

A DISCUSSION OF METHODS OF RAPID TRANSIT IN NEW YORK CITY WITH PROPOSITIONS FOR THEIR IMPROVEMENT.

Walter Wellman.

THE problems of personal transport are to be encountered in all great cities, and London, Paris, and New York have contended with them for many years. The task, however, has appeared to be an up-hill one, and for a good reason; the greater the transport facilities provided the greater the number of people attracted to the part of the city thus served, the remedy but increasing the demand. New York especially is feeling this congestion because of its geographical conditions. Formed like a great wedge enclosed between two wide rivers, with the business portion at the point, it is continually feeling the pressure of the daily tide which flows down in the morning and up in the evening, crowding every available means of transport to the utmost. The limited area of the small end of the wedge has proved no bar to the increase in the number of people therein during business hours, since the construction of buildings of increasing height has provided for present demands. These structures, containing from 1,000 to 6,000 people each, discharge their populations upon the streets and the transport accommodations at about the same time every evening, and the congestion which naturally results has become a matter for serious concern.

In a recently published pamphlet, Mr. Walter Wellman makes some suggestions which demand consideration in this place, leading as they do to a more radical treatment of the subject than has hitherto been considered.

Reviewing the growth of transport facilities from the stage coach single car, short train, and longer train, Mr. Wellman naturally arrives at the final arrangement, so far as the actual carrying portion of the problem is concerned, and commits himself to the continuous travelling platform. This may be placed either in a subway or on an elevated structure, and it should be provided with loops at the ends of the route, and be given a speed of about 24 miles per hour.

Given such a platform, the question which next arises is the method of transferring the passengers to and from the train at the desired points. One method, to which we shall refer again, is that used at Paris, and elsewhere, of having one or more auxiliary traveling platforms of slower speeds, so that the passengers may step successively from the stationary platform to the one which is moving at full speed, through the medium of the gradual changes. The other, now suggested by Mr. Wellman, includes the use of transferring platforms, these forming a portion of the main traveling platform, and being brought opposite the stations at all the stops.

This plan involves the rising of the passengers from their seats and their walking to the transfer portion of the platform as the station is approached, but it provides the full length of the station platform for the reception and discharge of passengers. It also involves the periodical stopping and starting of the entire platform, a matter which at present constitutes one of the chief difficulties with isolated trains. Mr. Wellman's plan is undoubtedly a vast improvement over the present method of crowding and pushing, but it seems unfortunate that he has not gone further and accepted the continuously moving platform as the true solution of the question. Apparently he is afraid of the matter of obliging the passensengers stepping from a stationary platform to a slow-moving one and from thence to a faster one, and so on. Such a fear is wholly unnecessary. The experience at Paris demonstrated that every one accepted this method as altogether easy and safe. The old and feeble, as well as the youngest children, mounted the travelling sidewalk at the exposition without the slightest hesitation or difficulty, and during the entire period that it was in use there were but two slight casualties; one being the slipping of a lame man and the other the falling of a woman carrying one child with another dragging at her skirt, and neither of these instances had any serious results. Can we say as much for the thousands who daily dodge the surface electric cars in New York to-day?

Mr. Wellman does well in all that he proposes, but he does not propose nearly enough. The travelling sidewalk is the one and only satisfactory solution of the transport problem in New York, but it should be a continuously moving platform, making no stops, except perhaps for one or two hours in the night for inspection and repair. The whole structure should be on an elevated level, giving a second street level, extending from one house line to the other. This would provide a second set of entrances to all shops, etc, and permit the surface of the ground to be employed for heavy traffic and merchandise. The middle of the street should be fitted with a travelling pavement, never stopping, and boarded and left at any point by means of platforms of secondary speed, as at Paris. A large part of the present congestion is due to the existence of landing stations, where the traffic is concentrated, and this should not be permitted, everyone being allowed to get on or off at any point. The capacity of such a platform is immense, and no one would get on at a crowded point when it would be easy to wait a few minutes until a convenient portion came along. The absence of the inertia shocks, due to starting and stopping would mean the removal of a large portion of the cause of wear and tear, all braking appliances being rendered unnecessary, while the ability to alight at the very point desired would go far to improve the service.

The principal objection to such a plan, admitting that there is not the slightest objection to getting on or off of such a platform, lies in the impracticability of collecting fares on a system which has no stations, no obstructing wickets, and no ticket takers. As a matter of fact, none of these obstructing appliances is necessary. In the tall buildings of New York, Mr. Wellman remarks that the elevator has got far ahead of the street car. He is right, but he has forgotten that there is no special ticket required to ride on an elevator, and that the service is rendered as an essential part of the conduct of a modern office building. At the present time it is held to be one of the duties of a municipality to provide streets and sidewalks for its residents. Before long it may well be required of the same municipality that these same sidewalks shall no longer be stationary, but shall be kept in motion, as well as cleaned, paved, and lighted. With such a service the stream of people will move at a speed demanded by the conditions of modern life, to the benefit of the whole community and the prosperity of the place which has realized that safe and certain transport is one of the essentials of the modern city.

POWER FROM COKE OVEN GASES.

METHODS OF COLLECTING, PURIFYING, AND UTILIZING THE DISCHARGE GASES FROM COKE OVENS FOR THE PRODUCTION OF MOTIVE POWER.

Bergassessor Baum—Glückauf.

SO much has been said nad written of late about the utilization of the waste gases from blast furnaces that another source of power for internal-combustion engines has been comparatively overlooked, although not entirely forgotten. In works for the production of illuminating gas the coke is considered as a by-product, but in the vast number of ovens in operation for the production of furnace coke the gas has either been allowed to go entirely to waste, or has been used only in some secondary or by-product process in which its high calorific power has been but partially utilized.

The production of gas by the coke oven varies according to the character of the coal which is coked, and also depends upon the temperature and other conditions of the operation. The leaner coals, which require a high temperature for the production of a satisfactory coke, may furnish but little more gas than is required for the heating of the oven, but in all such cases the use of a portion of the gas to preheat the air will result in a marked economy in the working. Richer coals, requiring a lower temperature for coking, furnish a greater proportion of gas, so that there will be from 20 to 40 per cent. of the gas available for power purposes after the necessary amount for the ovens has been taken. In this connection the injurious effect of moisture in the coal may be observed, a large proportion of the heating value of the gas being required for the vaporization of the moisture. Herr Baum gives results from several coking coals, including those from the Saar district, from Silesia, and from Moravia, from which it is shown that when a smaller proportion of gas is produced it generally has a higher calorific value. The thermal value of the coke-oven gases thus examined varied from 2,000 to 4,335 calories per cubic metre, or about 225 to 485 B. T. U. per cubic foot, so that it is well adapted for use in the gas engine, lying about midway between coal gas and the average of blast furnace gases.

In preparing the coke-oven gas for use in the cylinder of an engine several operations of purification have been found necessary. The principal impurities to be considered are tar, ammonia, cyanogen, and sulphur. To remove these the gases are first passed through a condenser, or surface cooler, by which the temperature is reduced from about 280° C. to 100° to 70° C., this operation causing the condensation of the greater part of the tar. A second system of coolers lowers the temperature to about 25° C., removing the remainder of the tar, this operation being followed by the passing of the gases through scrubbers in direct contact with water for the removal of the ammonia, sulphuretted hydrogen, and cyanogen. A variety of mechanical modifications of these machines have been devised, some of the more important of which are described at length and illustrated at length in the paper of Herr Baum. Other methods of removal of the sulphur and the cyanogen, by means of iron ore, in a manner similar to that employed for the purification of coal gas, are also described.

The gas is best drawn from the ovens by means of exhausters, several forms, of the rotary type, of which are described, and the gas delivered into holders, the supply from a number of ovens contributing to maintain uniformity of composition. By the use of automatic pressure regulators the supply is maintained at a constant pressure in the mains, and a steady supply delivered to the motors.

Herr Baum gives descriptions of a number of gas engines suited for use with coke-oven gases, these covering practically all the well-known designs, such as those of Otto, Koerting, Oechelhauser, the Nürnberg works, Cockerill, etc., showing their adaptability either for direct-connection with blowing cylinders, or for the driving of electric generators for the production of motive power or for illumination. The latter portion of the paper constitutes a very complete review of the present state of the art of the construction of large gas engines, including valve gears, regulation, and the general subject of combined generating sets composed of gas engines and direct-connected dynamos.

The entire question of the utilization of waste gases, of which but a single portion is considered in this exhaustive paper, is one demanding increasing attention. When the gas engine was first made a practical machine, it was tacitly assumed that it would be used only in connection with illuminating gas as fuel, questions of convenience outweighing those of operative cost. Tests soon demonstrated the high thermal efficiency of the internal-combustion engine, and later experience with special forms of gas producers gave most encouraging results. All this time the fact that metallurgical furnaces were emitting great volumes of fuel gas, especially adapted for use in such motors, was overlooked, and indeed had such sources of supply been considered they could hardly have been utilized until the development of electrical generating, transmitting, and power-application devices rendered them available. At first the idea that the gas engine was adapted for small powers only acted as a hindrance to further progress, but this gradually gave way before the practical demonstrations of successive builders, so that it is now a well established fact that the waste gases from blast furnaces, coke ovens, and other metallurgical furnaces may be employed to great advantage, not only for furnishing the power to drive the blowing cylinders and other machinery of the works in which they are located, but also for providing current for local distribution.

ELECTRIC AND HYDRAULIC DOCK MACHINERY.

COMPARATIVE PERFORMANCES OF ELECTRIC AND HYDRAULIC CRANES FOR CARGO HANDLING AT THE MIDDLESBROUGH DOCK.

Vincent L. Raven—Institution of Mechanical Engineers.

AT several meetings of the Institution of Mechanical Engineers the comparative merits of hydraulic and electric power for the operation of hoisting machinery have been discussed, and an interesting paper describing the trials made at the Middlesbrough Dock was presented at the recent meeting of the Institution in Chicago by Mr. Vincent L. Raven, the Chief Assistant Mechanical Engineer of the North Eastern Railway. Since Middlesbrough is an important shipping port for merchandise carried between England and the Continent, the location was an excellent one for determining the successful operation of cargo handling machinery, and the conditions of the trials appear to have been such as to furnish reliable data.

Ever since the development of the hydraulic crane by the late Lord Armstrong, its use has extended in all parts of the world, and there is little doubt that the development of the modern mechanically equipped harbor is largely due to the introduction of this important class of machinery. Of late, however, the rapid development of the electric transmission of power, together with the installation of generating stations for lighting purposes, has led to the introduction of electrically driven cranes and hoists, and hence a rivalry between the two systems has appeared.

The cranes in use at the Middlesbrough Dock are of a type well known in harbor equipment, consisting of radial jib cranes mounted upon travelling gantries high enough to permit a locomotive and train to pass beneath, the gantry spanning the railway track laid close to the quay wall. This form of crane is most convenient for transferring merchandise from the waggons to the vessels, or vice versa, and with hydraulic power it has been in use at many important seaports. After a number of years' experience, similar cranes with electric power machinery have been installed at Middlesbrough and Mr. Raven has instituted a series of comparative trials in order to determine the respective advantages of the two types. As the hydraulic cranes were some fifteen years old at the time of the installation of the new machines it was thought advisable to have them thoroughly overhauled, and as no changes in design had been made in the general type, the comparison may be considered as fairly satisfactory.

The trials were made to resemble as nearly as possible the actual working conditions of the machines, this being done by lowering into the dock a tub, itself weighing one ton, and holding two tons of water, the load of three tons being hoisted and swung around upon the quay wall and emptied, and then swung back again. Similar trials were made by lifting uniform and variable loads of rails, both types of cranes being subjected to the same tests, and the power required and the time taken in each case being carefully recorded. Such trials enable comparative results to be made more accurately than if the handling of actual loads is timed and measured, since the loads cannot be made uniform in actual service, and other operative conditions affect the time required.

In general the report is highly in favor of the electric machines. Mr. Raven appears to emphasise especially the fact that they are much less wasteful of power, the saving in this respect being from 25 to 50 per cent. over the hydraulic cranes. While this is a matter for examination, it is by no means the main consideration. A much more important feature is found in the greater rapidity of action of the electric cranes. This appears, not only in the greater speed of hoisting and sluing, in which movements a gain of 50 per cent. in time was shown, but also in the greater ease with which the machines could be shifted on the rails and refixed in new positions for operation.

It is in these elements of greater facility of action that the electric machines show their greatest advantage, this feature corresponding to the gain in the use of electric machinery elsewhere. The saving in actual power consumed usually bears a trifling proportion to the gain in money secured by the more rapid handling of the cargo, and the saving in the time of attendants. The power cost, while an element always to be considered, is never so great as the labor cost, while the fixed charges are usually as great as all the other expenses taken together, so that any appliance by which time is saved usually effects a saving much greater than its cost.

There are a number of minor features about the use of electric machinery about docks which appear in Mr. Raven's paper. Thus, in cold weather it is necessary to maintain fires, involving the attendance of caretakers, to prevent the hydraulic machines from injury by freezing, while with the electric cranes no such care is required. The cost of electric distribution of energy is also lower than that of hydraulic power; according to Mr. Raven's estimate this showing a gain of 50 per cent. Altogether the whole report shows so many advantages for the electric machinery that there is every reason to believe that for this special service at least, the hydraulic machinery must take second place. It does not follow from this that hydraulic cranes and hoisting machinery are to be entirely superseded by the electrically driven machines. In the opinion of Mr. Ellington there will always be a place for both types of machines, each supplementing the other. In some cases economy of power will doubtless be the controlling element, but in others, and by far the greater number of instances, economy of time is of far greater value, while in all the question of safety from accident must be considered, since a single disaster might involve a far greater loss of value, not to speak of life, against which the increased cost of working is the cheapest form of insurance.

THE ENGINEERING INDEX

"THE KEYSTONE IN THE ARCH OF APPLIED SCIENCE"

The following pages form a DESCRIPTIVE index to the important articles of permanent value published currently in about two hundred of the leading engineering journals of the world—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every article.

(1) The full title,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published.

We supply the articles themselves, if desired.

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer and works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of any article referred to in the Index, together with all illustrations, can usually be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the journals indexed are given.

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CIVIL ENGINEERING

BRIDGES.

Accident.

A Pin Bridge That Stood Without an End Post. John C. Moses. Illustrates and describes a bridge damaged by a railroad accident, and comments by way of explanation are given. 800 w. Eng News—May 19, 1904. No. 62983.

Arch.

The Adolphe Bridge at Luxembourg (Le Pont Adolphe à Luxembourg). M. Sejourné. Brief description of the double masonry arch of 84.65 metrès span. 1200 w. Comptes Rendus—May 2, 1904. No. 62840 D.

The Four Track Stone Arch Bridge of the Pennsylvania Railroad Across the Susquehanna River. Illustrates the bridge at Rockville, and the steel bridge removed, giving information concerning them. 500 w. Sci Am Sup—May 7, 1904. No. 62590.

Bascule.

The Harway Avenue Bascule Bridge, New York City. Illustration and description of bridge over Coney Island Creek, having a clear span of 50 feet, built of medium steel. 800 w. Eng Rec—April 30, 1904. No. 62528.

Cairo.

New Bridges at Cairo. Particulars relating to three new bridges to span the Nile. 1400 w. Engr, Lond—May 13, 1904. No. 62777 A.

Designs.

Design of a Fixed-Ended Arched-Rib Highway Bridge. Charles Derleth, Jr. Gives calculations, stress sheets and general drawings for a steel arch-ribbed bridge. Ills. 6500 w. Cal Jour of Tech—May, 1904. No. 62623 C.

I. Effect on Trusses and Plate Girders Due to Imperfect Roller Support. George N. Linday. II. Railway Bridge Calculation by End Shear Table. Josiah Gibson. Two papers with discussions on points in bridge design. 8700 w. Jour W Soc of Engrs—April, 1904. No. 62641 D.

Types and Details of Bridge Construction; Plate Girders. Frank W. Skinner. Presents examples of interesting construction work that has been actually erected, selected with a view to their value to bridge designers, draftsmen, city engineers, and others. 2200 w. Ills. Eng Rec —May 21, 1904. Serial. 1st part. No. 62760.

Erection.

Electric Cable-Way Over the Zambesi River. An illustrated description of an interesting cable-way in Africa, erected to transport material for building the highest bridge in the world across this river, and for making the railway. 1500 w. Engng—April 22, 1904. No. 62420 A.

Fraser River

The Fraser River Bridge, British Columbia. The present article gives an illustrated detailed description of the approaches and plate-girder spans. 2200 w. Eng Rec—April 30, 1904. Serial. 1st part. No. 62522.

Railway Bridge.

The Shubenacadie River Bridge—Midland Railway. J. J. Taylor. An illustrated detailed description of the construction of a single track bridge over a river 1,220 feet wide at the point of crossing, where the tides were extremely high and swift. 8000 w. Can Soc of Civ Engrs, Adv Proof—Jan. 28, 1904. No. 62434 D.

Reinforced Concrete.

A Concrete-Steel Highway Bridge at Plainwell, Mich. P. A. Courtright. Illustrated description of a bridge across the Kalamazoo River, and its construction. 2800 w. Eng News—May 12, 1904. No. 62667.

Melan Concrete Steel Arch Bridge Across the Great Miami River, Dayton, Ohio. Illustrated detailed description of the bridge and its construction. 2800 w. Eng News—May 19, 1904. No. 62978.

Skew.

A Novel Piece of Bridge Construction at Lawrence, Mass. M. F. Brown. Illustrates and describes a novel method of solving the problem of a skew crossing. 1100 w. Eng News—May 12, 1904. No. 62662.

Suspension.

The Elizabeth Suspension Bridge at Budapest (Die Elisabeth-Kettenbrücke in Budapest). Dr. Karl Rosenberg. With details of foundations, construction, and erection. Eye-bar cables are used for a span of 290 metres. Two articles. 3 plates. 5000 w. Zeitschr d Oesterr Ing u Arch Ver—April 22, 1904. No. 62824 each D.

Transporter Bridge.

Transporter Bridge Across the Manchester Ship Canal. Illustrated description of a bridge, nearing completion, which has a clear span of 1,000 feet. 1400 w. Sci Am—May 28, 1904. No. 62958.

Widening.

The Widening of the Birsig Viaduct at Bâle (Die Verbreiterung des Birsigviaduktes in Basel). The roadway is increased in width from 7.5 metres to 16 metres by the addition of auxiliary arches and flooring on each side. 1800 w. Schweiz Bauzeitung—April 23, 1904. No. 62844 B.

CONSTRUCTION.

Armory.

The Fifth Regiment Armory, Baltimore. Illustrated description of the interesting structural features, especially the drill-hall roof. 2400 w. Eng Rec—May 14, 1904. No. 62675.

Building Collapse.

The Collapse of a Building During Construction. H. de B. Parsons. Brief description of the construction and collapse of the Hotel Darlington. Ills. 1600 w. Pro Am Soc of Civ Engrs—April, 1904. No. 62443 E.

Building Construction.

The Construction of the Times Building, New York City. An illustrated general description. The present article deals especially with the foundations and excavation. 3500 w. Eng Rec—April 30, 1904. Serial. 1st part. No. 62524.

Caissons.

Caisson Illness and Diver's Palsy; an Experimental Study. Leonard Hill, and J. J. R. Macleod. Abstract of an article in the *Journal of Hygiene*. On the effects of compressed air on the human system and the cause of the disease known as "the bends," and the method of its prevention. A valuable article. 8000 w. Eng News—May 5, 1904. No. 62574.

Cofferdams.

Interlocking Steel Sheet Piles for

Bridge Pier Cofferdams. Illustration with detailed description of substructure construction of the Cuivre River bridge, about 60 miles from St. Louis. 1500 w. Eng Rec—April 30, 1904. No. 62526.

Exposition.

The Building of a World's Fair. An illustrated description of how the Louisiana Purchase Exposition has been constructed, with map showing civil engineering works on grounds. 9600 w. Eng Rec—May 7, 1904. No. 62576.

Foundations.

Foundations of the Sturtevant Hotel, New York City. Brief description of deep foundation work where surrounding buildings had shallow foundations, in a congested business district. Ill. 700 w. Eng Rec—May 14, 1904. No. 62680.

Roads.

A Difficult Piece of Road Building. From a report by J. J. Albertson. An account of the building of a road across salt meadows between Pleasantville and Atlantic City. 1200 w. Eng Rec—May 21, 1904. No. 62757.

St. Louis Exhibition.

The Building Construction of the St. Louis Exhibition. Illustrated article describing in detail the construction of these buildings. 6500 w. Eng News—May 19, 1904. No. 62984.

Steel Skeleton.

The Use of Steel in American Lofty-Building Construction. B. H. Thwaite. Read before the Iron & Steel Inst. Briefly reviews the history of the use of iron and steel in building construction, describing the system, and discussing its advantages and disadvantages. 3800 w. Ir & Coal Trds Rev—May 6, 1904. No. 62739 A.

Tunneling.

The Electric Plant at the Karawanka Tunnel (Die Elektrische Anlagen am Karawanken Tunnel). Johann Perl. A full account of the use of electric power in the boring of the tunnel through the Karawanka Alps in Carinthia. The bore is 7,969 metres long. 5000 w. Zeitschr d Oesterr Ing u Arch Ver—May 6, 1904. No. 62825 D.

Tunnels.

The Harlem River Tunnel of the New York Rapid Transit Railroad. The conditions and very shallow depth made the construction difficult, and the methods employed are illustrated and described. The present article describes the work on the second half of the tunnel. 2800 w. Eng Rec—May 14, 1904. No. 62676.

Pennsylvania R. R. Tunnel under North River. An illustrated account of an exhibit at the World's Fair of a full-sized section, showing the construction, concrete lining, screw pile and bridge system, &c., with information concerning this great work. 1700 w. Ry & Engng Rev—May 21, 1904. No. 62797.

MATERIALS OF CONSTRUCTION.

Cement.

The Cement Age: The Many New Uses and Increasing Demand for Plastic Materials. A topical discussion, introduced by R. W. Lesley. 6800 w. Pro Engrs' Club of Phila—April, 1904. No. 62632 D.

Cement Works.

A New Spanish Portland Cement Works. Illustrated detailed description of new works in Spain, built by American engineers and equipped with American machinery, operated entirely by water power. 1800 w. Eng News—May 5, 1904. No. 62570.

Discussion of Published Data on the Thermal Efficiency of the Rotary Kiln, and Possible Reduction of Fuel Requirement. Henry S. Spackman. Gives an analysis of investigations. Also editorial. 4200 w. Eng Rec.—May 14, 1904. No. 62682.

Compression.

The Influence of Lateral Pressure upon the Crushing Resistance of Solids (Influence des Pressions Laterales sur la Résistance des Solides a l'Ecrasement). A. Considère. Data of tests made upon cylinders of mortar, surrounded by hydraulic pressure, and subjected to axial crushing. 1800 w. Comptes Rendus—April 18, 1904. No. 62834 D.

Concrete.

Concrete: Its Properties and Applications. A topical discussion introduced by Edgar Marburg. 13000 w. Pro Engrs' Club of Phila—April, 1904. No. 62633 D.

Loam and Clay in Sand for Concrete. G. J. Griesenauer. Gives a record of tests made, with remarks on the results. 1200 w. Eng News—April 28, 1904. No. 62493.

Making Concrete Water Tight. Editorial discussion giving conclusions drawn from experiments of various investigators. 2200 w. Eng News—May 19, 1904. No. 62979.

Reinforced Concrete.

Reinforced Concrete in Building Construction. Emile G. Perrot. Calls attention to the application of this material to building construction, particularly to factory or mill building, discussing it from the architects' standpoint, and showing the advantages and drawbacks incident to its use. General discussion. Ills. 6800 w. Pro Engrs' Club of Phila—April, 1904. No. 62634 D.

Tests to Destruction of a Ferro-Concrete Truss. From *Annales des Ponts et Chaussees*. Describes tests of a regular open-work truss built entirely of ferro-concrete at Ivry, and tested to destruction.

1200 w. Engng—April 22, 1904. No. 62416 A.

Test to Destruction of a 65-ft. Truss Bridge Span of Reinforced Concrete. Abstract from *Annales des Ponts et Chaussées,* concerning a test made by Mr. Considère, describing the test structure, and giving results of tests. Ills. 2000 w. Eng News—May 5, 1904. No. 62571.

The Cottancin System of Armoured Construction. A. R. Galbraith. From a paper read before the Society of Architects. States the advantages claimed for these methods of armoured construction, the uses to which they are applied, results, &c. 3800 w. Archt, Lond—April 29, 1904. No. 62596 A.

See also Civil Engineering, Bridges.

Slag.

The Utilization of Blast Furnace Slag. E. R. Sutcliffe. Abstract of a paper read before the West of Scotland Ir. & Steel Inst. Describes the methods of making building bricks and artificial paving materials. Ills. 4800 w. Ir & Coal Trds Rev—April 15, 1904. No. 62393 A.

MEASUREMENT.

Geodesy.

Report of the Commission upon the Geodetic Operations at the Equator (Rapport Presente au Nom de la Commission Chargeé du Controle Scientifique des Opérations Géodesiques de l'Equateur). Progress report of the Commission of the French Academy upon work done in Ecuador during 1903. 2500 w. Comptes Rendus—April 25, 1904. No. 62836 D.

The Determination of Difference of Longitude by Transport of Timepieces (Essai d'une Détermination de Difference de Longitude par Transport de l'Heure). Paul Ditisheim. A determination of the difference in longitude between Paris and Neuchatel by transport of chronometers provided with compensated balances of nickel-steel alloy. 1200 w. Comptes Rendus—April 25, 1904. No. 62837 D.

The Present Status of Geodesy (L'Etat Actuel de la Géodésie). R. Bourgeois. A review of the latest methods of accurate base and angle measurement, with especial reference to the work of the French equatorial expedition. 5000 w. Rev Gen des Sciences—April 30, 1904. No. 62842 D.

Land Surveys.

Origin of the United States Land Surveys. W. A. Truesdell. Information concerning the early public surveys of this country. 3500 w. Jour Assn of Engng Socs—April, 1904. No. 62628 C.

Surveying.

Recent Methods of Hydrographic Surveying. A. S. Cooper. Briefly describes recent important developments, discussing their accuracy and cost. 1200 w. Eng News—May 19, 1904. No. 62980.

Tractograph.

Wide Tire Tests. Lawson M. Fuller. Report of a Board of Officers of the Ordnance Department of the United States army, describing the tractograph used and results obtained. 2000 w. Munic Jour & Engr—May, 1904. No. 62539 C.

MUNICIPAL.

Municipal Plant.

Tullahoma, Tenn., Water and Light Plant. Granbery Jackson. Brief history and description of a high voltage transmission line, with report of results obtained. 2800 w. Munic Engng—May, 1904. No. 62437 C.

Pavements.

Brick Pavement Construction. Ira O. Baker. Calls attention to neglected details, discussing the width of pavement, the subgrade, foundations, brick, cushion, and joint filler. 3000 w. Munic Jour & Engr—May, 1904. Serial. 1st part. No. 62540 C.

Records.

Sewer Contractor's Records. Ernest McCullough. Describes a method developed by the writer. 900 w. Eng News—May 19, 1904. No. 62982.

Sewage Disposal.

A Bird's-Eye View of Some Twenty-five British Sewage Works. Brief accounts with general comments. 3000 w. Eng News—May 12, 1904. No. 62663.

Practical Points in Sewage Disposal Works. Extracts from a paper by Henry C. H. Shenton, before the Soc. of Engrs., discussing the latest practice, particularly from the point of view of an engineer. 3000 w. Eng Rec—May 14, 1904. No. 62683.

Sewers.

A Reinforced Concrete Sewer at Wilmington, Delaware. T. Chalkley Hatton. Illustrated description of the sewer and its construction. 2500 w. Eng Rec—May 21, 1904. No. 62753.

Extensions of the Brooklyn Sewerage System; Ninety-Second Street Trunk Sewer. Begins an illustrated detailed description of a large sewer under construction, which will drain a territory of about 1,904 acres. 4000 w. Eng Rec—April 30, 1904. Serial. 1st part. No. 62525.

Extensions of the Brooklyn Sewerage System; Sixtieth Street Sewer. Describes the construction of a sewer built in open cut, although the trench has a maximum depth of 43 ft., and the minimum depth is 34 ft. 2000 w. Eng Rec—May 21, 1904. No. 62756.

The Cleaning and Flushing of Sewers. From a discussion at the annual meeting of the Sanitary Section of the Boston Society of Civil Engrs. 1200 w. Eng Rec—April 30, 1904. No. 62529.

The Design and Construction of the Proposed Sewer System for Darmstadt (Der Bau von Entlastungs Kanälen und die Grundlagen des Neuprojektes der Kandisation von Darmstadt). H. Heyd. With map, showing the location of collectors, and the details of drainage. 6000 w. 1 plate. Gesundheits-Ingenieur—April 30, 1904. No. 62871 B.

WATER SUPPLY.

Aqueducts.

Important Considerations in the Designing of Large Aqueducts. Extracts from Appendix III. of the report of the commission on an additional water supply for New York City, in regard to economies in construction and improvements in design of the proposed aqueduct. 2700 w. Eng Rec—May 21, 1904. No. 62754.

Boston.

Report on the Measurement, Consumption, and Waste of Water Supplied to the Metropolitan Water District. Report on the supply of Boston and adjacent towns. Dexter Brackett. 13000 w. Jour N Eng W-Wks Assn—June, 1904. No. 62922 F.

Color.

Studies of Color in Water; Metropolitan Water Supply, Massachusetts. Ernest G. Hopson. Discusses means tried for reducing color, and the action in Massachusetts for the prevention of coloring. 4600 w. Eng News—April 28, 1904. No. 62494.

Croton Works.

Progress Report on the Croton River Works for New York City's Water Supply. Information from the report of J. Waldo Smith, giving the present condition of this great work. Ills. 1800 w. Eng Rec —May 7, 1904. No. 62577.

Danville, Ill.

Filter Plant and Other Improvements for the Water Supply of Danville, Ill. Illustrated description of dam, mechanical filter plant, increase in pumping capacity and distribution, &c. 3300 w. Eng News—April 28, 1904. No. 62489.

Filtration.

A Mechanical Filtration Plant for Watertown, New York. Illustrated detailed description of this plant, with information related. 3500 w. Eng Rec—May 21, 1904. Serial. 1st part. No. 62755.

Note upon the Operation of Sand Filters (Contribution à l'Etude des Filtres â Sable). M. Marboutin. A study of the action of open sand filters by an examination of the proportion of dissolved oxygen in the filtered water. 1200 w. Comptes Rendus—April 18, 1904. No. 62835 D.

Hawaii.

Methods of Obtaining Water Supply for Sugar Plantations in the Hawaiian Islands. J. N. S. Williams. Describes methods of irrigation in a country very much cut up by gulches, and on islands where an artesian supply was available. Ills. 3000 w. Can Min Rev—April 30, 1904. No. 62500 B.

Irrigation.

Notes on Egyptian Irrigation. Information concerning the various engineering works carried out in different parts of Egypt. 4500 w. Builder—April 23, 1904. No. 62398 A.

Metering.

Rates for Metered Water. A topical discussion, opened by Freeman C. Coffin. 8000 w. Jour N Eng W-Wks Assn—June, 1904. No. 62926 F.

The Detection and Prevention of Water Waste at Marion, Ohio. Edward H. Cowan. Explains the policy adopted in establishing meters, and the results. 2500 w. Jour N Eng W-Wks Assn—June, 1904. No. 62924 F.

Water Consumption in Pittsburg and the Probable Effect of Metering. Gives information regarding water consumption in various cities, compiled with the view of showing the relation between per capita consumption and the installation of meters. 2500 w. Eng Rec—May 14, 1904. No. 62678.

Ozone.

Purification of Potable Water by Means of Ozone. Dr. Gg. Erlwein. Read before the Deutscher Verein von Gas und Wasserfachmaennern. An illustrated account showing what may be expected of the employment of ozone in connection with sterilization of water. 3500 w. Sci Am Sup—April 30, 1904. Serial. 1st part. No. 62535.

Pipes.

The Life of Cast-Iron Pipe. C. Cavallier. An account of the condition of pipes in Paris after being nearly 30 years in service, with notes on old water pipe systems in France. 1200 w. Jour N Eng W-Wks Assn—June, 1904. No. 62925 F.

Protection.

Preventing the Growth of Algae in Water Supplies. Extracts from Bul. No. 64, Dept. of Agriculture, by George T. Moore and Karl F. Kellerman, on the use of copper sulphate for the treatment of water supplies, with comments and editorial. 9500 w. Eng News—May 26, 1904. No. 62964.

The Lines of Defence in the Protection of Water Supplies. J. Cartwright. An article by an English engineer discussing the best means of protecting the supply of cities. Also editorial referring to American conditions. 3300 w. Eng News—April 28, 1904. No. 62490.

Pumping Engines.

See Mechanical Engineering, Hydraulics.

Reservoirs.

Some Notes on Cost of Waterproofing the Concrete Lining of Reservoirs. W. C. Hawley. Discusses the Sylvester process and variations of it, describing the application made and giving cost. General discussion. 3500 w. Jour N Eng W-Wks Assn—June, 1904. No. 62923 F.

St. Louis.

The Water-Works at St. Louis. An illustrated description of the water tower, settling basins, pumping station, pumping engine, &c. 3300 w. Engr, Lond—May 13, 1904. No. 62773 A.

Sedimentation.

On Sedimentation. Allen Hazen. A discussion of the subject from a theoretical standpoint, giving computations which show the reasons for several forms of construction now used. 10700 w. Pro Am Soc of Civ Engrs—April, 1904. No. 62441 E.

Tower Collapse.

A Water Tank Tower and Its Collapse. Illustrates and describes the tower collapse at Abilene, Tex., discussing the faulty design. 1200 w. Eng News—May 19, 1904. No. 62981.

Underground Waters

Underground Waters Adjacent to Surface Streams. C. G. Hubbell. Concerning subsurface waters along large water courses as a pure supply, and the methods of obtaining this water. 1000 w. Eng News—April 28, 1904. No. 62491.

WATERWAYS AND HARBORS.

Canals.

A New Ship Canal at South Buffalo. Illustrates and describes interesting engineering features. 1000 w. R R Gaz—May 27, 1904. No. 62966.

Canals and Navigable Waterways of Belgium. Interesting information from a recent report by Consul-General Hertslet. 3300 w. Col Guard—May 6, 1904. No. 62714 A.

The New Canal Plans (Die Neue Kanalvorlage). A review of the latest plans for a system of internal waterways in Germany, with estimates of cost, and extensive maps. 4000 w. 4 plates. Glückauf—April 23, 1904. No. 62846 B.

Canal Traction.

Electric Towing and the Electric Traction System on the Teltow Canal (Elektrische Treideleiversuche und Einführung des Elektrischen Schleppbetriebes auf dem Teltowkanal). Erich Block. With numerous illustrations of traction motors for canal service and results of tests of performance. 4000 w. Glasers Annalen—April 15, 1904. No. 62829 D.

Dam.

The Gatun Dam. C. D. Ward. Map and suggestions for a dam at this point on Panama Canal, if investigations show it to be more desirable than the Bohio project. 2000 w. Pro Am Soc of Civ Engrs—April, 1904. No. 62442 E.

Docks.

Floating Transfer Dock at Barcelona (Le Dock Flottant à Transfert de Barcelone). Daniel Bellet. With illustrations of the 6,000 ton off-shore depositing dock in actual service. 2000 w. Revue Technique—May 10, 1904. No. 62820 D.

The Stuyvesant Docks at New Orleans. An illustrated detailed description, with general plan of docks and yards. 800 w. R R Gaz—May 13, 1904. No. 62670.

Drainage.

Progress of Construction of the New Orleans Drainage System. Information from the last semi-annual report of the Sewerage and Water Board in regard to the progress. 1800 w. Eng Rec—April 30, 1904. No. 62527.

Dredge.

The Hydraulic Dredge. "J. Israel Tarte." A. W. Robinson. An illustrated detailed account of this dredge and of the work on which it is engaged on the St. Lawrence River. 6000 w. Can Soc of Civ Engrs—Adv. Proof. No. 62436 D.

Floods.

The Subsidence of Floods in Rivers (Sur les Décrues des Rivières). Edmond Mallet. A comparison of observations upon the relative subsidence of swollen streams in cold and warm seasons. 1000 w. Comptes Rendus—April 25, 1904. No. 62838 D.

Nile.

The Nile Dams (Die Stauwerke des Nils). A general account of the works at Assouan and Assiout, with map, sections, and photographs. Two articles. 3000 w. Schweiz Bauzeitung—April 16, 23, 1904. No. 62843 each B.

Whirlpools.

The Direction of Rotation of Whirlpools in the Rivers of Central Europe (Sur le Sens de Rotation des Tourbillons d'Eaux Courantes dans l'Europe Centrale). Jean Brunhes. A communication to the French Academy calling attention to the fact that 90 per cent. of the whirlpools revolve in the opposite direction to the hands of a watch. 1500 w. Comptes Rendus—April 11, 1904. No. 62833 D.

MISCELLANY.

Engineering Works.

Some Early Engineering Works in Pennsylvania. Edwin F. Smith. An illustrated review of early work, and the difficulties met and overcome. 7000 w. Pro Engrs' Club of Phila—April, 1904. No. 62631 D.

ELECTRICAL ENGINEERING

COMMUNICATION.

Protection.

The Protection of Telephone or Telegraph Lines When in Hazardous Proximity to High Tension Lines. Robert E. Chetwood, Jr. Illustrates and describes the most modern practice of the Bell Telephone system, explaining methods of cross-arm construction designed to reduce the possibility of accident. 1300 w. Elec Wld & Eng—May 21, 1904. No. 62947.

Recorder.

The Electro-Capillary Recorder for Cable Purposes. J. Tarbotton Armstrong and Axel Orling. Illustrated description of an instrument which the inventors claim will enable them to receive 400 to 500 letters per minute. 1100 w. Page's Mag—May, 1904. No. 62780 B.

Railway Service.

Improvements in Telephony and Telegraphy for Railways (Neuerungen in Telephonie und Telegraphie für Eisenbahnen). Dr. Ebeling. Describing improved signal systems, rapid printing telegraphs, Pupin coils, etc., and their special application to railway service. 4500 w. Glasers Annalen—May 1, 1904. No. 62831 D.

Space Telegraphy.

Methods for Increasing the Transmitter Energy of Wireless Telegraph Systems. Prof. Ferdinand Braun. Discusses increasing the energy by increasing the capacity, and also by raising the charging voltage, and describes improved methods. 2000 w. Elect'n, Lond—April 22, 1904. No. 62414 A.

The Application of Resonance Transformers in Space Telegraphy (Ueber Resonanzinduktorien und ihre Anwendung in der Drahtlosen Telegraphie). Dr. Georg Seibt. A mathematical examination of the process of tuning transmitters and receivers. 7500 w. Elektrotech Zeitschr—April 7, 1904. No. 62852 B.

The Metamorphosis of Wireless Telegraph Apparatus. A. F. Collins. A review of the changes and improvements which have been made in space telegraphy during the past seven years. 5000 w. Engineering Magazine—June, 1904. No. 62884 B.

Wireless Telephony with the Aid of the Selenium Cell (La Téléphonie sans Fil au Moyen des Piles à Selenium). A. Gradenwitz. A review of the experiments of Ruhmer by which articulate messages have been transmitted over a space of 7 kilometres. Two articles. 3000 w. Revue Technique—April 25, May 10, 1904. No. 62816 each D.

Telegraph.

The Donald Murray Rapid Telegraph (Ueber den Schnell telegraphen von Donald Murray). A. Kraatz. With numerous illustrations of the perferator, transmitter and receiver, as used in the Royal telegraph offices. 6000 w. Elektrotech Zeitschr—April 28, 1904. No. 62857 B.

Telephony.

Automatic Telephone Exchange of the Northeastern Telephone Company at Portland, Me. Reviews the history of the company and gives an illustrated description of the new exchange. 1400 w. Am Elect'n—May, 1904. No. 62501.

The Plant of the Kansas City Home Telephone Company. Max Loewenthal. An illustrated description of the exchange and its equipment with an account of the formation of the company. 2500 w. Elec Wld & Engr—April 30, 1904. No. 62549.

DISTRIBUTION.

Drop.

The Determination of Drop in Voltage in Parallel Three-Phase Lines (Zur Bestimmung des Induktiven Spannungsabfalles Paralleler Drehstromleittingen). Leo Lichtenstein. A mathematical discussion, showing possible sources of error in voltage measurements. Two articles. 6000 w. Zeitschr f Elektrotechnik—April 24, May 1, 1904. No. 62869 each D.

Earthing.

Earth Returns for High-Potential Currents. From the *Elektrotechnische Zeitschrift.* A report of experimental investigations. 1500 w. Elec Engr, Lond—May 13, 1904. No. 62772 A.

Factories.

Electric Distribution to Small Manufactories at Sant Mortier, France. Franz Koster. An illustrated description of an hydro-electric plant which furnishes power to many small consumers. 2500 w. Elec Wld & Engr—April 23, 1904. No. 62452.

High Voltage.

The Prevention of Crosses Between Signalling and High-Voltage Circuits. Howard S. Knowlton. Considers some of the dangers due to the increasing number of circuits carrying high-potential currents, and the methods of preventing them. 2500 w. Elec Wld & Engr—April 23, 1904. No. 62455.

Insulated Wires.

How Insulated Wires and Cables Are Made. Henry A. Morss. Illustrates and describes the manufacture of rubber insulated wires and cables. 3800 w. Cent Sta—May, 1904. No. 62693.

Networks.

The Rational Computation of Current Distributing Networks (Die Rationelle Berechnung von Stromverteilungsnetzen). Dr. E. Müllendorff. A mathematical investigation to determine the relation between the central station and the consumers for a minimum expenditure of copper. Two articles, 7000 w. Elektrotech Zeitschr—April 14, 21, 1904. No. 62853 each B.

Power.

Some Economic Aspects of Electrical Power Distribution. Edmund L. Hill. Abstract of a paper read before the South Wales Inst. of Engrs. The advantages of the power distribution companies in Great Britain are discussed, and the value of the diversity factor to a power company. 2000 w. Ir & Coal Trds Rev—April 15, 1904. No. 62394 A.

Wiring.

The Wiring of Exposed Steel Frame Buildings. Arthur B. Weeks. Sketches and notes describing methods used. 1500 w. Am Elect'n—June, 1904. No. 62977.

ELECTRO-CHEMISTRY.

Electric Smelting.

Electric Smelting Experiments for the Manufacture of Ferronickel from Pyrrhotite. Ernst A. Sjostedt. Read at meeting of the Am. Elec-Chem. Soc. An account of electric smelting experiments made at Sault Ste. Marie. Ills. 2400 w. Elec Rev, N. Y.—May 14, 1904. No. 62659.

Electrometallurgy in the Iron Industry (Electrometallurgic. Industrie du Fer). L. Francois and L. Tissier. The first of a series dicussing the production of iron and steel in the electric furnace. 2000 w. Revue Technique—May 10, 1904. No. 62821 D.

Some Electric Furnace Processes. J. Wright. Deals with some of the more important industries which have been made possible by the intense heat of the electric furnaces. Ills. 7200 w. Cassier's Mag—May, 1904. No. 62782 B.

The Electric Smelting of Iron Ores. Gives the conclusions of the best authorities who have investigated this subject. 2000 w. Can Min Rev—April 30, 1904. No. 62497 B.

The Electric Steel-Furnace at Gysinge, Sweden. F. A. Kjellin. Illustrated description of the furnace and smelting process. 1600 w. Trans Am Inst of Min Engrs—Oct, 1903. No. 62939.

Electrodes.

Electrodes of Artificial Graphite (Ueber Elektroden aus Künstlichem Graphit). Dr. Alfred Gradenwitz. A comparison of natural and artificial graphites as electrodes in commercial electrolytic operations. 1500 w. Elektrotechnische Zeitschr—May, 1904. No. 62864 G.

Electro-Metallurgy.

Electrolytic Iron. Prof. C. F. Burgess and Carl Hambuechen. Read at the Washington meeting of the Electro-chemical Soc. A report of experimental investigations of the conditions suitable for electrolytically depositing iron, showing that it can be produced in such quantities and at such cost as to make it of commercial importance. 2300 w. Sci Am Sup—May 7, 1904. No. 62593.

Rectifiers.

Electrolytic Rectifiers for Charging Storage Batteries with Alternating Current. Charles F. Burgess. Read at Milwaukee meeting of the N. W. Elec. Ass'n. An explanation of the properties and peculiarities of the electrolytic rectifier. 2500 w. Sci Am Sup—April 30, 1904. No. 62534.

Storage Batteries.

Storage Battery Plate Construction with Special Reference to High Discharge Characteristics. W. W. Donaldson. Considers the construction of plates best adapted to high discharge work. 3000 w. Elec Wld & Engr—May 21, 1904. No. 62950.

Zirconium.

The Production of Crystallized Zirconium in the Electric Furnace (Ueber die Darstellung des Sogen. Kristallisierten Zirkoniums im Elektrischen Ofen). E. Wedekind. With a discussion of the reactions, and microphotograph of the crystalline effect. 2000 w. Zeitschr f Elektrochemie—May 6, 1904. No. 62866 G.

ELECTRO-PHYSICS.

Alternating Currents.

The Braun Tube in the Study of Alternating Currents. Describes the Braun tube, explaining its use for this purpose, referring to experiments carried out by Prof. A. Petrovski. Ills. 2000 w. Elec Wld & Engr.—April 30, 1904. No. 62551.

Direct-Current.

The Pulsation of the Direct-Current Output of Rotary Converters. Translation in abstract of an article by R. Elsasser in *Elektrotechnische Zeitschrift.* An attempt to show that the chief cause of the pulsations is the superposition of the ohmic voltage drops due to the direct current and the alternating current within the armature conductors. 2000 w. Elec Engr, Lond—April 29, 1904. No. 62604 A.

Radioactivity.

Radioactive Substances (Ueber Radioaktive Stoffe). W. Marckwald. An address before the Elektrotechnische Verein, giving a general account of the present knowledge of radioactive materials. 7500 w. Elektrotech Zeitschr—April 2, 1904. No. 62855 B.

The Preparation of Radium, Vanadium and Uranium Compounds from Carnotite and Pitchblende. J. Ohly. Explains methods and observations made, giving conclusions. 2000 w. Min Rept—May 12, 1904. No. 62695.

GENERATING STATIONS.

Alternators.

Theoretical Basis for the Experimental Pre-Determination of the Regulation of Alternators. Dr. Theo. Torda-Heymann. Describes a method which the writer considers will more nearly coincide with actual facts, applying it to examples given by B. A. Behrend in an earlier article. 1600 w. Elect'n, Lond—April 22, 1904. No. 62413 A.

The Oscillation of Parallel-Connected Alternators (Das Pendeln Parallel Geschalter Wechselstrommaschinen). A. Sommerfeld. A mathematical analysis of the phenomena of surging in parallel running of alternators. Two articles. 10000 w. Elektrotech Zeitschr—April 7, 14, 1904. No. 62851 each B.

Steam Alternator at Bedford. Illustrations with brief description. 1400 w. Engr, Lond—May 6, 1904. No. 62725 A.

Central Station.

A Rapidly Growing Western Central Station. E. A. Barth. Illustrated description of the generating plant of the Kansas City Electric Light Company. 5800 w. Am Elect'n—June, 1904. No. 62971.

Some Aspects of New England Central Station Development. An illustrated article giving an interesting account of the development and transmission of electric energy. 8000 w. Elec Wld & Engr—May 21, 1904. No. 62944.

The Combined Use of Alternating and Direct Current for Central Station Work. F. C. Caldwell. Read before the Ohio Elec. Soc. States the conditions that have led to the combined use, considering the question from the point of view of the consumer, the distribution and the station. 3300 w. Engr, U S A—May 15, 1904. No. 62699.

The Present Possibilities of the Gas Producer and Gas Engine for Central Station Purposes. Discusses the subject from the viewpoint of conditions in England. 1400 w. Elec Rev, Lond—April 29, 1904. No. 62605 A.

Charges.

The Question of Charges for Electricity Supply (Beitrag zur Tariffrage der Elektrizitätswerke). H. Schönborn. With diagram showing the variation in consumption and its influence upon charges. 2500 w. Elektrotech Zeitschr—May 12, 1904. No. 62861 B.

Design.

Notes on the Design and Construction of Buildings Connected with the Generation and Supply of Electricity Known as Central Stations. Charles Stanley Peach. Also discussion, illustrations and 20 plates. 2300 w. Jour Roy Inst of Brit Archts—April 2, 1904. No. 62397 H.

Power Station Design. C. H. Merz and William McLellan. Abstract of a paper read before the Inst. of Elec Engrs. Discusses the unnecessary expenditure often bestowed on the power station, considering the main principles governing the design, and discussing the effects on actual design. 4500 w. Elect'n, Lond—April 29, 1904. Serial. 1st part. No. 62610 A.

Fire Hazards.

The Reduction of Fire Hazards in Electric Plants. Howard S. Knowlton. Discussing especially the relation of electricity to fire risks, with a review of methods which minimize the hazards from this source. 3500 w. Engineering Magazine. June, 1904. No. 62883 B.

Hydro-Electric.

Hudson River Power in Albany, Troy and Schenectady. An illustrated detailed account of the interesting power developments around Albany. Relates to the utilization of the power at various points. Also editorial. 4300 w. Elec Wld & Engr—May 14, 1904. No. 62701.

The Electric Power Station of the New Richmond Roller Mills Company. R. D. Thomas. Illustrated description of a small hydroelectric plant in Wisconsin. 1600 w. Elec Rev, N. Y.—April 30, 1904. No. 62487.

The Snoqualmic Falls and White River Power Developments. An illustrated account and description of the properties of this company. 4000 w. Elec Wld & Engr—May 7, 1904. No. 62650.

The Utilization of the Water Power of the Glommen at Kykkelsrud (Die Ausnutzung der Wasserkräfte des Glommens bei Kykkelsrud). I. H. Kinbach. A fully illustrated account of the extensive hydroelectric station in Norway, where 44,000 horse-power is being developed. Two articles. 6000 w. 1 plate. Zeitschr d Ver Deutscher Ing—April 23, 30, 1904. No. 62802 each D.

South Boston.

Expansion of the Boston Edison System. Illustrated detailed description of the steam turbine station at South Boston, which is to have a capacity of 60,000 kilowatts. 6500 w. Elec Wld & Engr—May 21, 1904. No. 62943.

The New Generating Station of the Edison Electric Illuminating Company. Illustrated detailed description of the steam turbine plant on L street, South Boston, Mass., and its relation to the Edison Company's system. 6000 w. Elec Rev, N. Y.—May 21, 1904. No. 62789.

Sparking.

The Computation of Equipotential Connections (Ueber die Berechnung von Aequipotentialverbindungen). Arthur Müller. A discussion of methods for the prevention of sparking of commutators. Two articles. 5000 w. Zeitschr f Elektrotecknisch—April 17, 24, 1904. No. 62867 each D.

Synchronizer.

The Construction of a Two-Phase Synchronizer. Paul C. Percy. Drawings and description of a two-phase synchronism indicator of the "revolving light" type. 1500 w. Am Elect'n—June, 1904. No. 62975.

Works.

Description of the Grimsby Corporation Electricity Works. Walter A. Vignoles. Ills. 2500 w. Elec Engr, Lond—May 6, 1904. No. 62710 A.

LIGHTING.

Arc Lamps.

Small Candle-Power Enclosed-Arc Lamps for City Street Lighting. J. H. Hallberg. Facts relating to these lamps and their success for street lighting. 3000 w. Am Elect'n—June, 1904. No. 62973.

The Magnetite Arc Lamp. Charles Proteus Steinmetz. Illustrated description of this new illuminant, with explanation of the operation. 1200 w. Elec Wld & Engr—May 21, 1904. No. 62949.

Contract.

New York Retail Contract. George T. Hanchett. An explanation of the details of the contract upon which electricity for lighting is sold. 2000 w. Cent Sta—May, 1904. No. 62691.

Illumination.

Electrical Illumination of the Louisiana Purchase Exposition. Cloyd Marshall. Describes features of exterior and interior lighting. Ills. 1200 w. Elec Wld & Engr—May 21, 1904. No. 62948.

Fallacies in Illumination. E. Leavenworth Elliott. A number of curious and amusing fallacies are explained. 2200 w. Cent Sta—May, 1904. No. 62692.

Improvements in the Technology of Illumination (Neuerungen der Beleuchtungs technik). W. Wedding. A comparison of the illuminating value of various sources of light, on a basis of operative cost and effect. 2000 w. Zeitschr d Ver Deutscher Ing—May 7, 1904. No. 62809 D.

The Transmission of Light Waves of Various Lengths through Fog (Untersuchungen über die Durchlässigkeit von Nebel für Lichtstrahlen von Verschiedener Wellenlänge). A. Rudolph. Data and results of exhaustive experiments showing the greater penetrating power of rays from the red end of the spectrum. 2500 w. Zeitschr d Ver Deutscher Ing—April 30, 1904. No. 62806 D.

Lamps.

A Resumé of Incandescent Electric Lamp Exhausting. S. E. Doane. Brief review of the history of the development of this art, especially considering the present chemical exhausting method. 4000 w. Elec Wld & Engr—May 21, 1904. No. 62945.

The Problems of Improving Electric Lamps. Henry Noel Potter. Reviews the six prominent systems of electric lighting, studying the problems of each with a view to their improvement. 3500 w. Elec Rev, N. Y.—May 21, 1904. No. 62788.

Mercury Arc.

A New Mercury-Arc Lamp with Automatic Starter (Eine Neue Quecksilberbogenlampe mit Automatischer Zündung). Dr. Heinrich Paweck. The mercury tube is mounted on a vertical axis, and started by rotating it; this breaking a mercury short circuit, and causing the current to pass through the vapor. 2000 w. Zeitschr f Elektrochemie—April 29, 1904. No. 62865 G.

Nernst.

Street Lighting by Nernst Lamps. Henry Joseph. Aims to show that, under favorable conditions, with the use of Nernst lamps, it is possible to produce a better light than that given by incandescent mantles at a smaller annual cost and profit. 3000 w. Elec Rev, Lond—May 13, 1904. No. 62770 A.

The Nernst Lamp. An illustrated review of the development of this lamp, with account of its efficiency, regulation, &c. 5400 w. Elec Wld & Engr—May 21, 1904. No. 62951.

MEASUREMENT.

Conductivity.

The Conductometer. Rollo Appleyard. A defence of this instrument invented by the writer, in reply to a recent paper by John Rymer-Jones. 1300 w. Elec Rev, Lond—May 13, 1904. Serial. 1st part. No. 62771 A.

The Measurement of Electrical Conductivity. J. Rymer-Jones. The present article considers the use of the conductometer, and the ordinary meter-bridge, and the objections to them, as introductory to another system to be described later. 1500 w. Elec Rev, Lond—April 29, 1904. Serial. 1st part. No. 62608 A.

Counter.

A New Mechanical Apparatus for Computing Current Consumption (Ueber einen Neuen Apparat für die Mecanische Herstellung von Stromrechnungen für Elektrizitätswerke). F. Biermann. Describing a form of mechanical counter for summing up the reading of electric meters, and reducing the clerical labor. 3500 w. Elektrotech Zeitschr—May 5, 1904. No. 62860 B.

Diagrams.

Operating Diagrams of an Alternator (Sur les Diagrammes de Fonctionnement d'un Alternateur). C. F. Guilbert. Discussing methods of constructing the characteristic curves of alternating-current dynamos. Serial. Part I. 2500 w. Revue Technique—April 25, 1904. No. 62819 D.

Indicators.

Construction of a Three-Phase Synchronizer. Paul C. Percy. Illustrates and describes in detail how a useful synchronism indicator may be produced. 1300 w. Am Elect'n—May, 1904. No. 62503.

Oscillographs.

Recording Alternating-Current Wave-Forms by Duddell Oscillographs. Illustrates and describes the instrument and its uses. 3000 w. Sci Am Sup—May 28, 1904. No. 62961.

Recording Instruments.

Curve Drawing or Graphic Recording Instruments. H. W. Young. Explains the value of these instruments, describing the more important ones. 4000 w. Am Elect'n—June, 1904. No. 62974.

Reichsanstalt.

The Physical Technical Reichsanstalt (Die Physikalisch-Technische Reichsanstalt). An abstract of the work of the Reichsanstalt, to the close of 1903, with especial reference to the calibration of electrical instruments. 5000 w. Elektrotech Zeitschr—May 12, 1904. No. 62863 B.

The Work of the Electric Testing Office (Bekanntmachung über Prüfungen und Beglaubigungen durch die Elektrischen Prüfämter). Detailed report of tests of meters at the Reichsanstalt. 5000 w. Elektrotech Zeitschr—April 28, 1904. No. 62856 B.

Resistance.

Measurement of the Insulation Resistance of an Electric Wiring System. Edwin F. Northrup. Describes a voltmeter method and also a galvanometer method applicable for determining the insulation resistance of each side of any wiring system while the power is on. 900 w. Elec Wld & Engr—May 21, 1904. No. 62946.

Three-Phase.

The Measurement of Three-Phase Currents (Sur la Mesure de la Puissance des Courants Triphasés). Maurice Soubrier. Describing the method of connecting totalizing wattmeters for three-phase currents. 2000 w. Revue Technique—April 25, 1904. No. 62818 D.

Torque.

A Convenient and Economical Electrical Method for Determining Mechanical Torque. A. S. McAllister. Explains a method which is very accurate and applicable to all types of motors. 1400 w. Elec Wld & Engr—May 7, 1904. No. 62654.

Wattmeters.

Testing Recording Wattmeters. George T. Hanchett. Explains a method of testing and its value. 1300 w. Am Elect'n—June, 1904. No. 62976.

MOTORS.

Design.

Design of Continuous-Current Motors for Variable Speed. Franklin Punga. An explanation of the lines on which variable-speed motors should be built. 2300 w. Elec Rev, Lond—April 22, 1904. No. 62412 A.

Design of a 6-Horse-Power, Two-Cycle Motor. H. B. Maxwell. A set of working drawings for a 4¼ by 5 inch two-cycle motor that will develop 6 brake horse-power. 800 w. Marine Engng—May, 1904. Serial. 1st part. No. 62461 C.

Induction Motors.

The Design of Induction Motors with Examples from Recent European Practice. H. M. Hobart. Shows the dependence of the factor in Behrend's formula on the ratio of the length of the core to the pole pitch. 2500 w. Elec Wld & Engr —April 30, 1904. No. 62550.

TRANSMISSION.

High-Tension.

Some Experiences With High-Tension Transmission Lines. H. C. Reagan. Illustrates and describes experiences which have come under the observation of the writer. 1600 w. St Ry Rev—May 20, 1904. No. 62919 C.

Transformers.

Continuous-Current Transformers. J. W. Burleigh. Explains the method adopted by the writer for designing these machines, with remarks. Ills. 1500 w. Elec Engr, Lond—April 29, 1904. No. 62603 A.

The Elementary Principles of Transformer Design. Prof. Thomas Gray. Outlines a method of treatment which may be followed with advantage in making an original design. Deals mainly with the problem of maximum efficiency. 1800 w. Elec Wld & Engr—April 23, 1904. Serial. 1st part. No. 62454.

MISCELLANY.

Electrical Machinery.

Notes on the Design of Electrical Machinery. Louis Hunt. The first part of the paper deals with continuous-current machines, and the second part with alternating-current motors and generators. 2200 w. Mech Engr—April 23, 1904. Serial. 1st part. No. 62409 A.

Expositions.

Electricity at the Paris and St. Louis Expositions. Franz Welz. A comparison, showing the progress made in electricity during the four years since the Paris Exposition. Ills. 3800 w. Elec Wld & Engr—May 7, 1904. No. 62651.

Electrical and Mechanical Engineering in the Exposition Plant. J. R. Cravath. A summary of the work of the electrical and mechanical department of the Division of Works, which builds and operates the exposition. Ills. 1600 w. Elec Wld & Engr—May 7, 1904. No. 62652.

Wind Vane.

Electrically-Registering Wind Vane and Anemometer for School Use. H. W. Harmon. Illustrated description of devices for weather work used in teaching physics. 1600 w. Sci Am Sup—May 14, 1904. No. 62657.

GAS WORKS ENGINEERING

Acetylene.

Acetylene in German Villages. Information concerning consumption, price, success, &c. 1200 w. Engr, Lond—May 13, 1904. No. 62776 A.

Benches.

The Construction and Operation of Recuperative Benches No. II. W. A. Baehr. A discussion of the practical and important considerations of the materials of bench construction. Also general discussion. 15800 w. Pro Age—May 2, 1904. No. 62447.

Coke Breeze.

I. Burning Coke Breeze with Underfeed Stokers. N. E. Malone. II Burning Coke Breeze on Hollow Grates. C. H. Williams. Two papers read before the Ohio Gas Lgt. Assn. on the utilization of coke breeze as fuel. The first reports results of tests in Denver. The second reports a test at the gas plant of the Madison Gas & Electric Co. 4000 w. Pro Age—May 2, 1904. No. 62446.

Flow.

An Examination of Threlfall's Work on the Flow of Gases in Pipes. Discusses the investigations made and their application to the construction of a meter for the measurement of "Mond" gas. 2000 w. Jour Gas Lgt—April 19, 1904. No. 62-392 A.

Fuel.

Gas as Fuel in Mechanical Heating Processes—Why the Dearer Fuel is Often the Best to Use. Edward P. Reichhelm. Presents reasons why gas blast-furnaces are economical. 1200 w. Am Mach—April 28, 1904. No. 62486.

Gasholder.

The Construction of a Large Modern Gasholder. Information from a paper by W. Doig Gibb on the new gasholder erected at St. Anthony's. Ills. 2500 w. Jour Gas Lgt—May 10, 1904. No. 62730 A.

Gas Plant.

The Development of the Modern Gas Plant. Thomas D. Miller. Read at meeting of Southwestern Gas, Electric and Street Railway Assn. Briefly reviews the history of the discovery of gas giving properties in coal, and the development, improvements, &c. 2500 w. Am Gas Lgt Jour—May 16, 1904. No. 62688.

Natural Gas.

Natural Gas History. F. H. Oliphant. From pamphlet issued by the U. S. Geol. Survey. An interesting review of the history of natural gas in the United States. 4000 w. Pro Age—May 16, 1904. No. 62684.

Oxide.

Economy in Oxide Purification. Henry L. Rice. Gives some results in purification at the Norfolk, Va., works. 2000 w. Gas Engrs' Mag—May 10, 1904. No. 62-729 A.

Photometry.

Mr. Jacques Abady on "Photometry." A lecture on photometry in relation to gas testing. 8000 w. Jour Gas Lgt—May 3, 1904. No. 62713 A.

Pressure.

Some Thoughts on the Regulation of Pressure. Thomas Glover. Read before the E. Co.'s Gas Mgrs.' Assn. Abstract. Gives the writer's experience in exhausting gas from retorts under somewhat unusual conditions, and discusses regulation of pressure. General discussion. 3500 w. Gas Wld—April 23, 1904. No. 62406 A.

Price.

A Plea for One Price. Norton H. Humphreys. Suggesting that the price be given in plain figures and all discounts and financial accommodation stated as a separate transaction. 1500 w. Jour Gas Lgt—May 3, 1904. No. 62712 A.

Producer.

Deschamp's Down-draft Gas Producer. An illustrated description with report of tests. 3800 w. Ir & Coal Trds Rev—May 13, 1904. No. 62953 A.

Retorts.

Horizontal v. Inclined Retort Installations, with Notes on Coke Conveying. J. G. Newbigging. Read before the Manchester Dist. Inst. of Gas Engrs. Considers the costs of the two systems, the durability, production, &c., describing work undertaken by the writer, and giving information of interest. 4300 w. Gas Engrs' Mag—May 10, 1904. No. 62728 A.

The Mechanical Operation of a Gas Retort House (La Manutention Mécanique dans l'Atelier de Distillation d'une Usine à Gaz). A. Thibeault. A very complete account of recent methods of mechanically charging and drawing gas retorts, both horizontal and inclined. Three articles. 9000 w. 3 plates. Génie Civil—April 16, 23, 30, 1904. No. 62811 each D.

Tynemouth.

Recent Extensions, Etc., at the Tynemouth Gasworks, North Shields. A. Clement Hovey. Read before the N. of England Gas. Mgrs.' Assn. A report of recent extensions and working results with discussion. 7000 w. Gas Wld—May 7, 1904. No. 62708 A.

Water Gas.

Leading Water Gas Through Coal Gas Retorts. Herr Croissant. Summary of an address before the Mid-Rhine Dist. Assn. A record of experiments and conclusions. 1600 w. Gas Wld—May 14 1904. No. 62765 A.

Works.

A Study of Some American Gas-Works. A. J. Walker. Comments on things seen and heard during a recent visit to the United States and Canada. 1600 w. Jour Gas Lgt—May 3, 1904. Serial. 1st part. No. 62711 A.

INDUSTRIAL ECONOMY

Apprentices.

The Apprenticeship Systems of the Baldwin Locomotive Works. S. M. Vauclain. An authoritative account of the successful apprentice systems of the great locomotive works in Philadelphia. 3000 w. Engineering Magazine—June, 1904. No. 62880 B.

Chemical Engineer.

The Chemical Engineer. Report of a paper by J. B. F. Herreshoff, and of the discussion. Deals with the training of a chemical engineer. 3200 w. Electro-Chem Ind—May, 1904. No. 62644 C.

Compensation.

Five Years' Experience of the Effect of the Workmen's Compensation Acts. William H. Tozer. Abstract of a paper read before the Royal Statistical Soc. A review with the inference that the Acts have been beneficial to the working classes. 5000 w. Ir & Coal Trds Rev—April 22, 1904. No. 62476 A.

Cost Keeping.

Pattern Costs. R. W. MacDowell. Explains a system of keeping accurate costs of patterns, giving forms used. 1500 w. Ir Trd Rev—May 5, 1004. No. 62544.

Education.

Technical Education: London and Birmingham. C. Alfred Smith. Explains the systems to be given a trial at these two cities. The systems are entirely different, under almost similar conditions. 1400 w. Elec Rev, Lond—April 22, 1904. No. 62411 A.

The Education of the American Electrical Engineer. Prof. W. E. Ayrton. Reprint from the "Mosely Ed Com. Report." Information gathered during the recent visit to the United States. 3000 w. Elec Engr, Lond—April 22, 1904. Serial. 1st part. No. 62410 A.

Engineers.

The Relation of the Engineer to Finance. An address at the Univ. of Illinois by John W. Alvord. 2800 w. Eng Rec—May 21, 1904. Serial. 1st part. No. 62759.

Labor.

The Evil and the Good of Labor Unions. Address of Charles S. Mellen. (Abstract.) A notable address to a gathering of the employees of the New York, New Haven & Hartford railroad. 2000 w. Ry Age—May 6, 1904. No. 62560.

The Union Movement Among Coal-Mine Workers. Frank Julian Warne. A study of the trade union movement among the coal mine workers, pointing out the causes of the successes and failures marking its growth. 16800 w. Bul Bureau of Labor—March, 1904. No. 62467 D.

Laboratories.

The Engineering Laboratories at the South-Western Polytechnic, London. An illustrated detailed description of laboratories and their equipment for the instruction of students. 8700 w. Mech Engr—May 7, 1904. No. 62709 A.

The Equipment of a Laboratory for Metallurgical Chemistry in a Technical School. Charles H. White. States the principles to be observed in the equipment, and gives an illustrated description of the laboratory for metallurgical chemistry at Harvard University. 1400 w. Trans Am Inst of Min Engrs—Feb., 1904. No. 62933.

Premium System.

A Premium Plan of Wage Payment in a Repair Shop. A. W. Thompson. Describing the successful adaptation of the premium system to a drop having no fixed product. 2500 w. Engineering Magazine—June, 1904. No. 62882 B.

Rules.

Union Rules Submitted to the Atchison. Extracts from a proposed set of rules, with comments by J. W. Kendrick. 1700 w. R R Gaz—May 13, 1904. No. 62669.

St. Louis Exposition.

The International Exhibition at St. Louis, U. S. A. The present article is introductory to a description of this great enterprise, with remarks on the construction work. 2500 w. Engr, Lond—May 6, 1904. Serial. 1st part. No. 62724 A.

The Engineering Characteristics of St. Louis. The first of a series of articles, giving illustrated descriptions of engineering features of the city likely to be of interest to foreign visitors. 4000 w. Engr, Lond—April 22, 1904. No. 62424 A.

South Africa.

South Africa and Her Labor Problem. Charles Sydney Goldmann. Discusses present conditions in South Africa and the great need of labor, the remedy, &c. 7000 w. Nineteenth Cent—May, 1904. No. 62694 D.

Timing.

Estimating Time for Lathe Work. Henry Hess. Considers methods of estimating in use, giving charts. 3000 w. Mach, N. Y.—May, 1904. No. 62545 C.

Wage Methods.

Wage-Paying Methods from the Viewpoint of Invested Capital. Henry Hess. Mr. Hess's concluding paper gives a graphic study of the effects of various methods upon the funds used and the dividends paid. 3500 w. Engineering Magazine—June, 1904. No. 62887 B.

Wages.

A Rational Basis for Wages. Harrington Emerson. An interesting contribution to the labor problem, and the relations of the employer and employee, with especial reference to the development of the interested co-operation of the latter. 4800 w. Trans Am Soc of Mech Engrs, No. 022—June, 1904. No. 62905.

Works Management.

Staff and Departmental Organization. Hugo Diemer. Remarks on the advantages of organization, and suggestions for making a study of the system best suited to the factory. 1800 w. Ir Trd Rev—May 5, 1904. No. 62543.

MARINE AND NAVAL ENGINEERING

Boilers.

See Mechanical Engineering, Steam Engineering.

Cargo Handling.

Some Modern Quayside Cargo Appliances. Brysson Cunningham. Briefly reviews the modern systems of handling coal, grain, ore, oil, timber and other cargoes. Ills. 3500 w. Cassier's Mag—May, 1904. Serial. 1st part. No. 62781 B.

Cruiser.

Trial Trip of the U. S. Protected Cruiser Tacoma. Illustration, with description of the vessel and its machinery and report of trial. 1000 w. Marine Engng—May, 1904. No. 62460 C.

Ferryboat.

A New Southern Ferryboat. Illustrates and describes a wooden-hull screw ferry boat now under construction in Florida. 600 w. Naut Gaz—April 28, 1904. No. 62448.

Pacific Coast Ferryboat. Illustrated description of the Ramona, built for service in Southern California. 700 w. Naut Gaz—May 12, 1904. No. 62643.

Fire Prevention.

Fire Prevention on Board Ship. Edwin O. Sachs. Read before the Inst. of Naval Archts. Considers safeguards of construction and equipment, administrative arrangements, fire extinguishing, &c. 4500 w. Engng—May 6, 1904. No. 62722 A.

Floating Workshop.

The Training of Engine-Room Artificers. Describes a new departure for fitting engine-room artificers for the Royal Navy. An extensive floating department strictly under naval discipline. Ills. 2400 w. Engng—April 22, 1904. No. 62418 A.

The Training of Engine-Room Artificers for the Royal Navy. Illustrated description of the training ship Bellerophon to be used in fitting mechanics for the Royal Navy. 2500 w. Engr, Lond—April 22, 1904. No. 62425 A.

Ice-Breaker.

The Russian Ice-Breaker "Ermack." Illustrated description of the ice-breaking steamer designed by Admiral Makaroff. 1300 w. Sci Am—May 7, 1904. No. 62589.

Integraph.

The Uses of the Integraph in Ship Calculations. John G. Johnstone. A short description of the nature of the work of the integraph, and how it can be applied to calculations relating to a vessel's form. Also a short description of the machine and the properties of integral curves. Plate. 4000 w. Trans Inst of Engrs & Shipbuilders in Scotland—March 22, 1904. No. 62430 D.

Lake Steamer.

Steamer Augustus B. Wolvin of the Great Lakes. An illustrated description of the largest vessel ever built to navigate fresh waters. 1200 w. Marine Engng —May, 1904. No. 62462 C.

Life Saving.

Donvig's Life-Saving Globe. An illustrated description of this life-saving device, with reports of trials. 600 w. U S Cons Repts—May, 1904. No. 62428 D.

Lighthouse.

The Mile Rock Steel and Concrete Lighthouse, California. Illustrated detailed description. 1500 w. Eng Rec—May 14, 1904. No. 62677.

Merchant Marine.

German Merchant Marine. Reviews the history and development, describing the character of the German shipping and giving much information. 6000 w. U S Cons Repts—May, 1904. No. 62427 D.

The Merchant Marine (La Marine Marchande). Marcel Plessix. The first installment of a serial devoted to the development of merchant vessels and their influence upon international trade. Serial. Part I. 2000 w. Revue Technique —April 10, 1904. No. 62814 D.

Motor Boats.

How to Build a Power Dory. C. D. Mower. Drawings and description. 2200 w. Rudder—May, 1904. No. 62470 C.

Motor-Boat Hull Experiments. Illustrated account of a series of tests made with full-sized models for Napier boats. 700 w. Auto Jour—April 23, 1904. No. 62399 A.

New Power Boats. C. D. Mower. An illustrated article giving much information in regard to these boats, the different designs, &c. 3800 w. Rudder—May, 1904. No. 62469 C.

Oil-Burning.

12,726-Mile Run of the Nebraskan Burning Oil. An account of the run from San Diego to New York, steaming with oil fuel. Illustrates and describes the machinery, oil-burning system, operation, performance, &c. 2000 w. Marine Engng —May, 1904. No. 62459 C.

Painting.

Redman's System for Cleaning and Painting Ships. Illustrated description of a mechanical process, with statement of advantages. 1200 w. Engng—May 6, 1904. No. 62718 A.

Resistance.

Some Results of Model Experiments. R. E. Froude. A description of general experiments on systematic variations in form of hull, with results. 3700 w. Engr, Lond—May 6, 1904. No. 62727 A.

Scouts.

Sea Scouting. Editorial explaining the importance of these vessels, their use in warfare, and the requirements. 2800 w. Engng—April 22, 1904. No. 62421 A.

Screw Propellers.

The Problem of the Screw Propeller. John Lowe. An explanation of the writer's theory and calculations, testing by example. 2000 w. Sci Am Sup—May 28, 1904. No. 62960.

Steamships.

Steamship Design. Carl C. Thomas. A general description of the operations involved in designing vessels and their machinery. 4000 w. Cal Jour of Tech—May, 1904. No. 62624 C.

Steamship Service.

Trans-Atlantic Steamships. Reviews briefly the history of steam navigation on the Atlantic, giving an idea of the immense amount of money invested, the cost of a single passage for the large liners, and much interesting information. Ills. 5700 w. Naut Gaz—May 5, 1904. No. 62541.

Strength.

The Transverse Strength of Ships. J. Bruhn. Read before the Inst. of Naval Archts. Applies the method of least work to show the effect on the strength, of variations in the method of construction, or in the arrangement of the support and loading of ordinary cargo vessels. Ills. 4700 w. Engng—April 22, 1904. No. 62-422 A.

Torpedoes.

Torpedoes and Torpedo Warfare. Hudson Maxim. An account of the present state of the torpedo art, showing the advantage of greatly increasing the speed and range of the Whitehead torpedo. Ills. 4000 w. Rev of Revs—May, 1904. No. 62431 C.

Yachts.

H. H. Rogers' Steam Yach Kanawha. Illustrates and describes the vessel that holds the record as the fastest cruising steam yacht in America. 3500 w. Marine Rev—May 5, 1904. No. 62537.

Japanese Imperial Yacht Hatsukaze. Illustrated detailed description of the yacht and its equipment. 1800 w. Marine Engng—May, 1904. N. 62458 C.

MECHANICAL ENGINEERING

AUTOMOBILES.

Automobile Trains.

Continuously - Propelled Automobile Trains. Emile Guarini. An illustrated description of the Renard train and its operation. 1000 w. Sci Am Sup—May 14, 1904. No. 62655.

Auto Truck.

The Torbensen Gear Gasoline Auto Truck. An illustrated description of a truck for business uses. 1500 w. Ir Age—May 5, 1904. No. 62515.

Commercial Vehicles.

The Inwardness of Automobilism. M. C. Krarup. An examination of the deficiencies of present machines, deprecating the fact that pleasure vehicles have turned attention away from permanent improvements. The importance of better tires and fuels is emphasized. 4000 w. Iron Age—May 5, 1904. No. 62517.

Cooling.

The Cooling of Explosive Motors on Automobiles. J. Grouvelle and H. Arquembourg. States the causes that may increase or diminish the amount of heat absorbed by the cylinder wall, and discusses methods of getting rid of the heat. 2800 w. Mech Engr—April 30, 1904. No. 62602 A.

Electric Vehicles.

Electricity as a Motive Power for Automobiles. H. W. Alden. A lecture before the Boston Y. M. C. A. Discusses the importance of care and intelligent operation, cost, &c. 2000 w. Sci Am Sup—May 7, 1904. No. 62591.

Engines.

Compound Engine of the White Steam Car. Illustrated detailed description. 1000 w. Am Mach—May 26, 1904. No. 62955.

The Gasoline Engine as Applied to Automobiles. Albert L. Clough. Lecture before the Boston Y. M. C. A. Automobile School. Discusses the requirements. Ill. 4000 w. Mech Engr—May 14, 1904. No. 62768 A.

Engine Speeds.

Cylinder Dimensions and Engine Speeds Compared. J. W. Roebuck. Discusses the speed of motors, single cylinders, the ratio of bore to stroke, &c. 1400 w. Autocar—April 23, 1904. No. 62405 A.

Gasoline Cars.

Suggestions to the Inexperienced. A. D. River. A discussion of the principles of the gasoline car for the benefit of novices. Ills. 2400 w. Automobile—May 14, 1904. Serial. 1st part. No. 62686.

Ignition.

Ignition of Gasoline Motors. R. L. Hubler. Briefly describes obsolete methods of ignition and explains electric spark ignition, the generation and application of the current, &c. Ills. 4500 w. Marine Rev—May 5, 1904. No. 62538.

The Ignition or Induction Coil Explained. Illustrated description of the component parts and the action of the cell. 1600 w. Autocar—May 7, 1904. No. 62706 A.

Law.

Provisions of New York Automobile Law. A summary of the new license requirements with the advantages claimed, and complete text of the Hill Automobile Law. 4800 w. Automobile—May 14, 1904. No. 62687.

Locomotive.

A Powerful Gasoline Locomotive. Illustrated description of a gasoline motor for hauling freight cars across London. 600 w. Sci Am Sup—May 7, 1904. No. 62592.

Military.

Motor Cycles for Military Purposes. Lieut. H. G. de Watteville. A discussion of the advantages and disadvantages of motor cycles for scouting purposes, examining details of construction rendering them applicable for military service. 3500 w. Jour Unit Serv Inst—March 15, 1904. No. 62451 D.

Motor Cars.

Motor Cars. Alexander Govan. Deals with the various parts of the motor car from the time it commenced to be adopted for every day use, considering principally petrol-driven vehicles. 4 plates. 8500 w. Trans Inst of Engrs & Shipbldrs in Scotland—April 26, 1904. No. 62620 D.

Popular Motor Cars. Mervyn O'Gorman. Discusses devices used on motor cars, popular prejudices, &c., and urges that some discarded devices be reconsidered. General discussion. 6000 w. Jour Soc of Arts—April 22, 1904. No. 62404 A.

The Accessories of a Motor Car. Lieut. W. Windham. Describes the different parts of a motor car which are essential to its complement, but which are usually left to the buyers' choice. Gives what the writer considers the best, with reasons. 1300 w. Autocar—April 30, 1904. Serial. 1st part. No. 62598 A.

Napier.

The Napier Motor Car and Petrol Launch. An illustrated description of the petrol engine made to actuate motor cars and small vessels. 3700 w. Engng—April 22, 1904. No. 62417 A.

Petrol Car.

The 24-H. P. "Automotor" Petrol Car. Illustrated description of a fast touring car of the chain-driven type. 1500 w. Auto Jour—April 30, 1904. No. 62600 A.

Railway Automobiles.

Rail-Autocar for the Paris, Lyons, and Mediterranean Railway. Illustrated description of the design of the motor-car adopted by this road. 500 w. Engng—May 6, 1904. No. 62716 A.

Steam Automobiles for Railway Service (Nouvelles Voitures Automobiles à Vapeur pour Voies Ferrées). F. Barbier. Illustrating and describing a number of special and inspection cars for use in minor service on steam railways in France and England. 3000 w. 1 plate. Génie Civil—April 9, 1904. No. 62810 D.

The Petrol Electric Cars for the North Eastern Railway. Brief illustrated description. 800 w. Engng—April 22, 1904. No. 62419 A.

Renault.

The New 14 H. P. Renault. Illustrated description dealing principally with a novel arrangement of the water-cooling system, in this case of the natural or thermo-syphon type. 600 w. Autocar—April 30, 1904. No. 62597 A.

Silencers.

Design of Silencers. Rudolph E. von Lengerke. Describes a silencer of the writer's design giving his theories. Ill. 2500 w. Autocar—May 14, 1904. No. 62763 A.

Steering Gears.

Steering Gears for Motor Cars. C. H. Gale. On properly designing steering gear, giving tables, curves, and explanatory notes. 2000 w. Auto Jour—April 23, 1904. No. 62400 A.

Tyre Pumps.

The Automatic Tyre Pump — the "Pompeesi." Illustrated description of the apparatus and its operation. 800 w. Auto Jour—April 30, 1904. No. 62601 A.

Voiturettes.

The 6½-H.-P. Baby Peugeot. Illustrates and describes the 1904 model. 1600 w. Auto Jour—April 30, 1904. No. 62-599 A.

The Wolseley 6-H. P. Voiturette. Illustrated detailed description. 1200 w. Auto Jour—May 7, 1904. Serial. 1st part. No. 62707 A.

HEATING AND COOLING.

Buildings.

Heating and Ventilation of Buildings. R. C. Carpenter. Read before the Ohio Archt's Assn. Considers temperature required, effect of moisture, need of ventilation, various systems, &c. 3000 w. Dom Engng—April 25, 1904. No. 62445 C.

Capitol.

Heating and Ventilating the Minnesota State Capitol. Illustrates and describes an interesting plant on the plenum system. 3700 w. Eng Rec—May 21, 1904. No. 62758.

Cooling Plant.

Cooling Plant in Cologne Theater. Joseph Musmacher. Describes the refrigerating plant in a new city theater in Germany, in which heating, cooling and ventilating are all through the same conduits. Ills. 2400 w. Ice & Refrig—May, 1904. No. 62449 C.

Ice Machines.

Ice Machine Parts. T. R. Wingrove. Remarks on the need of attention to the parts in the erection of ice making plant, atmospheric condensers, purging oil out of condenser connections, &c. Ill. 2800 w. Ice & Refrig—May, 1904. No. 62450 C.

Office Building.

Heating and Ventilating a Works Office Building. Illustrated description of the plant installed for the administration building of the American Bridge Company at Ambridge, Pa., as an example of good practice. 2800 w. Eng Rec—May 14, 1904. No. 62679.

Refrigeration.

Mechanical Refrigeration of Freight Cars. Warren H. Miller. An illustrated description of the Miller system in which carbon-dioxide gas is used as the refrigerating medium. 2500 w. Stevens Ind—April, 1904. No. 62432 D.

Systems and Methods of Mechanical Refrigeration. Sterling H. Bunnell. A general review of the various methods of producing artificial cold, discussing details of practical construction and operation. 5000 w. Engineering Magazine—June, 1904. No. 62886 B.

The Common Systems of Mechanical Refrigeration. Sterling H. Bunnell. Explains the distinctive points of the various systems. 2500 w. Engr, U S A—May, 1904. No. 62698 C.

Regulation.

The Regulation of Low Pressure Steam Heating (Die Generelle Regelung der Niederdruckdampfheizung). F. Gremmels. A description of the use of throttling tubes for reducing steam pressure. 3000 w. Gesundheits-Ingenieur—April 20, 1904. No. 62870 B.

Ventilation.

Air and the Ventilation of Dwellings (Ueber Luft und Lüftung der Wohnung und Verwandte Fragen). Th. Oehmcke. A general discussion of the effect of impure air upon health and of the best methods of ventilation and the removal of dust. 8000 w. Gesundheits-Ingenieur—May 10, 1904. No. 62872 B.

The Humidification and Ventilation of Factories (L'Humidification et la Ventilation des Ateliers). Paul Razons. Describing various devices for supplying textile factories with air containing a predetermined amount of moisture. Two articles. 3000 w. Génie Civil—April 16, 23, 1904. No. 62812 each D.

HYDRAULICS.

Flow.

A Chemical Method of Measuring Water Flow (Methode Chemique pour la Mesure du Débit des Conduites d'Eau). F. van Iterson. The process consists in delivering a known volume of a solution of hyposulphite of soda into the suction of the pump, and analyzing the strength of the diluted discharge. 1000 w. Génie Civil—April 30, 1904. No. 62813 D.

Impulse Wheel.

Efficiency Test of an Impulse Wheel. Joseph N. Le Conte. An outline of the machinery used, the methods employed, and the preliminary results obtained, in the tests of a 3-foot impulse water wheel. Ills. 1800 w. Cal Jour of Tech—May, 1904. No. 62622 C.

Pumping Engines.

Some Recent Pumping Engine Tests. Frank A. Whitten. Brief description of the recent addition to the water supply of Chicago, with report of tests. 3000 w. Eng News—May 26, 1904. No. 62962.

Pumps.

The Use and Abuse of Direct Acting Steam Pumps. W. H. Wakeman. An illustrated article giving suggestions. 1700 w. Power—May, 1904. No. 62480 C.

INTERNAL-COMBUSTION MOTORS.

Alcohol.

The Need of Duty-Free Spirit for Industrial Purposes. Thomas Tyrer. A vast amount of information in regard to the manufacture, use, and duty on alcohol. General discussion. Refers to England principally. 27000 w. Jour Soc of Arts—April 29, 1904. No. 62594 A.

The Present Status of Alcohol in Technology (Ueber den Gegenwärtigen Stand der Technischen Spiritusverwertung). Dr. N. Wender. Giving statistics as to the production of alcohol in various parts of Europe, discussing its extending use as a fuel. Two articles. 5000 w. Zeitschr d Oesterr Ing u Arch Ver—April 8, 15, 1904. No. 62822 each D.

Gas Power.

Power from Coke-Oven Gases (Die Verwertung des Koksofengases). H. Baum. An exhaustive discussion of the composition, purification and utilization of the waste gases from coke ovens; with details of construction of ovens, purifiers and large gas engines. Serial. Part I. 5000 w. Glückauf—April 16, 1904. No. 62845 B.

Indicator Diagrams.

The Indicator Diagram of a High-Speed Petrol Motor. Prof. H. L. Callendar. Read before the Auto-Cycle Club, So. Kensington. Describes the method adopted for obtaining high-speed indicator diagrams, showing how the indicator may be utilized in the study of the theory of the motor, and as a guide to its practical improvement. 3000 w. Auto Jour—May 14, 1904. No. 62764 A.

Marine Work.

The Internal-Combustion Engine as a Means of Propelling Small Vessels. Arthur F. Evans. Read before the Inst. of Naval Archts. Reviews the various applications of motors to the propulsion of small vessels, and discusses the designs and development. 5700 w. Prac Engr—May 13, 1904. No. 62766 A.

Motors.

Internal Combustion Motors. Dugald Clerk. Abstract of a lecture before the Inst. of Civ. Engrs. Notes briefly what has been accomplished and discusses what remains to be done in the development of internal combustion motors. 2000 w. Engr, Lond—April 22, 1904. Serial. 1st part. No. 62426 A.

Testing.

Commercial Gas Engine Testing and Proposed Standard of Comparison. William P. Flint. Explains the value of the friction brake as a satisfactory means of measuring the power developed, describing the system of plotting the results of tests. Ills. 2500 w. Trans Am Soc of Mech Engrs, No. 032—June, 1904. No. 62910.

MACHINE WORKS AND FOUNDRIES.

Castings.

Green Sand Bottoms and Sound Castings. Suggestions and opinions in regard to molding. 1400 w. Foundry—May, 1904. No. 62439.

Some Zinc Alloys for Castings. Walter J. May. Information concerning alloys found useful for a variety of purposes. 800 w. Prac Engr—April 22, 1904. No. 62408 A.

The Casting of the Williamsburg Bridge Entablatures—A Notable Technical Achievement. Illustrations, with brief description of the casting of tablets 52 feet 7 inches long and 4 feet 3 inches wide. 800 w. Sci Am—May 28, 1904. No. 62959.

The Need of Standard Specifications for Gray-Iron Castings. Henry Souther. Discusses the proposed specifications, giving reports of tests of material made as directed, and information concerning the castings. 3500 w. Trans Am Inst of Min

The Influence of Varying Casting Temperature on the Properties of Steel and Iron Castings. Percy Longmuir. Experi-

mental work in which all conditions other than temperature are identical, the results showing the influence of varying casting Engrs—Feb., 1904. No. 62935.
temperature. 3200 w. Ir & Coal Trds Rev —May 6, 1904. No. 62740 A.

Crucibles.

Some Uses for Old Crucibles. J. F. Buchanan. Remarks on the treatment of crucibles, with suggestions for their profitable use when old. 1700 w. Foundry—May, 1904. No. 62440.

Cupolas.

The Effect of Limestone Additions on the Product in Cupola Practice, According to the Researches of A. Sulzer-Grossman, Winterthur. Edited by F. Wust. Translated by J. E. Johnson, Jr. An account of investigations. 2000 w. Am Mach—May 12, 1904. Serial. 1st part. No. 62586.

Dies.

An Automatic Push Feed and Gang Die. Jack Marks. Illustrates and describes an automatic die for making a scalloped cap of 1C tin. 900 w. Am Mach—May 5, 1904. No. 62547.

Electro-Magnets.

Practical Applications of Electro-Magnets in the Modern Machine Shop, Iron and Steel Works and Shipyard. Frank C. Perkins. Illustrated descriptions of electro-magnetic machines, their uses, types, &c. 2,000 w. Mod Mach—May, 1904. No. 62468.

Foundry.

Foundry of the American Locomotive Works, Schenectady, N. Y. An illustrated detailed description of an interesting plant. 1500 w. Foundry—May, 1904. No. 62438.

Jig.

The Hancock Jig. F. Danvers Power. Illustrated description of a jig of the reciprocating screen type, which has been largely used for treating ores of copper and lead in Australia. 1000 w. Eng & Min Jour—May 19, 1904. No. 62751.

Lathes.

Facing Pipe Flanges in the Field—An Improvised But Very Efficient Lathe. E. L. Mills. Illustrates and describes the facing of the flanges of thirty-four pieces of pipe in connection with work on the N. Y. aqueduct. 1000 w. Am Mach—April 28, 1904. No. 62484.

Lathe Spindle.

Bench Lathe Cone Spindle and Box Fitting. Detailed Account of a Delicate Piece of Work. John Randol. An illustrated description of spindle and box grinding. 2500 w. Am Mach—May 12, 1904. No. 62587.

Machine Tools.

Some Early Machine Tools. Calls attention to early contrivances devised to relieve hand labor. Ills. 3300 w. Engr, Lond—May 6, 1904. Serial. 1st part. No. 62723 A.

Specifications for Machine Tools. An account of the practice of various companies, giving examples. 2000 w. Eng News —May 12, 1904. No. 62666.

Milling.

A Milling Operation in a New York Shop. An illustrated description of work performed in a lathe instead of in a miller, showing the efficiency of the arrangement. 1000 w. Am Mach—May 5, 1904. No. 62546.

Pittsburg.

Frank-Kneeland Plant of the United Engineering & Foundry Co. Illustrated detailed description of the Pittsburg plant of this company, which is located at the foot of 54th street. 3500 w. Ir Trd Rev—May 5, 1904. No. 62542.

St. Louis Exposition.

The World's Fair Machinery Display. Lieut. G. L. Carden. Calls attention to notable exhibits and features of interest. Ills. 2300 w. Elec Wld & Engr—May 7, 1904. No. 62653.

Shear Blades.

Designing, Fitting and Tempering Shear Blades. T. Foot. An illustrated article showing the proper design of shear blades and their fittings for easy setting and adjustment. 1800 w. Am Mach—May 5, 1904. No. 62548.

Specifications.

Chemical Specifications for Pig-Iron. Edgar S. Cook. On the grading by chemical analysis and the difficulties besetting the accurate determination of the composition of sand-cast pig. Also discussion. 4500 w. Trans Am Inst of Min Engrs—Feb., 1904. No. 62934.

Steel Belts.

The Locke Steel Belt Machine. Illustrated description of a machine for automatically manufacturing steel sprocket chains. 2500 w. Ir Age—May 12, 1904. No. 62588.

Steel Foundry.

Hadfield's Steel Foundry, Sheffield. A brief description of the largest steel foundry in the world, covering 6 acres. 1600 w. Col Guard—April 22, 1904. No. 62415 A.

Tool Making.

Diamond Dust for Laps and Sapphires for Cutting Tools. Joseph M. Stabel. Information, with illustrations, of the use of these precious stones in the making of small tools of precision. 1500 w. Am Mach —May 26, 1904. No. 62956.

Wheels.

The Manufacture of Hydraulically Forged and Rolled Solid Steel Railway

Wheels. Henrik V. von Z. Loss. An illustrated description of the process used in the manufacture of wheels for steel cars, with much information related. 4700 w. Jour Fr Inst—May, 1904. No. 62629 D.

MATERIALS OF CONSTRUCTION.

Alloys.

Alloys of Copper and Arsenic. Arthur H. Hiorns. Experiments made to ascertain the exact relation between copper and arsenic in binary alloys, and the limit of proportion of arsenic that can be retained in copper in the cold solid state. Ills. 2800 w. Elec-Chem & Met—April, 1904. No. 62630 C.

Imperfect Equilibrium in Alloys. F. Osmond. An illustrated study. 1800 w. Ir & Steel Mag—May, 1904. No. 62638 D.

The Range of Solidification and the Critical Ranges of Iron-Carbon Alloys. H. C. H. Carpenter and B. F. E. Keeling. Researches testing the accuracy of conclusions reached in the paper by Prof. Bakhuis-Roozeboom. 2500 w. Ir & Coal Trds Rev—May 6, 1904. No. 62736 A.

Asbestos.

Asbestos and Its Uses. An illustrated description of asbestos from the raw material to the finished article, giving much information. 3000 w. Elec Rev, Lond—April 29, 1904. No. 62607 A.

Asbestos and Its Uses in Engineering. A. Leonard Summers. An illustrated article noting some of the more important uses made of this material in electrical and mechanical engineering. 1000 w. Prac Engr—May 13, 1904. No. 62767 A.

Metallography.

Microscopic Metallography (La Métallographie Microscopique). G. Cartand. The first installment of a serial treating of the development of the use of the microscope for the study of the physical structure of metals. Serial. Part I. 2000 w. Revue Technique—April 10, 1904. No. 62814 D.

Plastic Strain

The Plastic Yielding of Iron and Steel. Walter Rosenhain. Read before the Iron & Steel Inst. A re-examination of evidence, because of disagreement of French authors with results, and the new developments. Ills. 4500 w. Ir & Coal Trds Rev—May 6, 1904. No. 62737 A.

Steel.

Notes on Rail-Steel. Robert W. Hunt. On the importance of the mechanical treatment of the metal forming a steel rail, during its manufacture. 1500 w. Trans Am Inst of Min Engrs—Feb., 1904. No. 62940.

Sorbitic Steel. H. C. Boynton. An illustrated report of experimental researches, stating results. 2000 w. Ir & Steel Mag—May, 1904. No. 62637 D.

Stresses.

On the Relations Between the Effects of Stresses Slowly Applied and of Stresses Suddenly Applied in the Case of Iron and Steel. Pierre Breuil. Abstract of a paper before the Iron & Steel Inst. Results of investigations are discussed. 2200 w. Ir & St Trds Jour—May 7, 1904. No. 62618 A.

Testing.

Typical English Testing Machines. A. Francis. Illustrates types of commercial patterns, and describes methods, showing the advantage to engineers in determining the strength of materials. 1500 w. Page's Mag—May, 1904. Serial. 1st part. No. 62779 B.

Tool Steels.

High Speed Tool Steel, Its Manufacture and Uses. J. M. Gledhill. Abstract of paper read before the Coventry Engng. Soc. Illustrates and describes the process of crucible cast steel, defining some of the substances used in its manufacture, and giving particulars of some of the alloys; also considers high-speed steel and its development. 5500 w. Ir & Coal Trds Rev—April 22, 1904. No. 62475 A.

Tungsten Steel.

Researches Upon Tungsten Steels (Recherches sur les Aciers au Tungstène). Léon Guillet. Data and results of a systematic study of tungsten steels, with microphotographs showing the effect of quenching and tempering. Serial. Part I. 1800 w. Génie Civil—May 7, 1904. No. 62827 D.

MEASUREMENT.

Dynamometer.

A New Device for Measuring the Power of Motors (Sur un Nouvel Appareil Destiné à la Mesure de la Puissance des Moteurs). Ch. Renard. The power of the motor is absorbed by the resistance of the air to the motion of vanes on the revolving shaft. The power is measured by the size of the vanes and the rotative speed. 1500 w. Comptes Rendus—May 2, 1904. No. 62839 D.

Pyrometry.

Notes on Pyrometry. M. E. J. Gheury. Read before the Arc Works Engng. Soc., Chelmsford, Eng. Reviews briefly the different methods used in measuring high temperatures, paying special attention to those adapted to industrial requirements. 5200 w. Engng—May 6, 1904. Serial. 1st part. No. 62721 A.

Speed Variations.

A Method for Rendering Speed Variations Visible (Ein Verfahren zur Sichtbar machung Ungleich formigkeit bei Kraftmaschinen). Dr. P. Berkitz. The rotations of the engine shaft are compared with a uniformly rotating disc. 1000 w. Zeitschr f Elektrotechnik—April 17, 1904. No. 62868 D.

POWER AND TRANSMISSION.

Air Compressors.

Air Compressors and Blowing Engines. C. H. Innes. A mathematical demonstration of the work done in compressing air, illustrating by examples, is given in the present number. 2800 w. Prac Engr—April 22, 1904. Serial. 1st part. No. 62407 A.

Belts.

The Care and Management of Leather Belts. Walter E. Dixon. On the selection, care and management of belts. 2000 w. Power—May, 1904. No. 62479 C.

Bevel Gears.

Bevel Gears with Short Teeth. Robert A. Bruce. Gives proportions which apply to bevel wheels whose shafts are at right angles. 700 w. Am Mach—April 28, 1904. No. 62485.

Cone Pulleys.

Machining Cone Pulleys. Illustrates and describes the methods used at the works of the Lodge & Shipley Machine Tool Company. 600 w. Am Mach—May 12, 1904. No. 62585.

The Layout of Cone Pulleys. C. M. Sames. Mathematical demonstration. 500 w. Am Mach—May 19, 1904. No. 62747.

Conveying.

Balanced Cable Cranes for Handling Excavated Material at Devonport, England, and Zambesi Falls, South Africa. Describes the methods of excavation and the plants for handling materials. Ills. 1700 w. Eng News—May 12, 1904. No. 62665.

Cranes.

Modern Cranes (Neuere Krane). A. Müller. Illustrating improved gantry and titan cranes, of recent German design. Serial. Part I. 1500 w. Zeitschr d Ver Deutscher Ing—May 7, 1904. No. 62808 D.

Efficiency.

The Potential Efficiency of Prime Movers. C. V. Kerr. A discussion of water-wheels, steam engines, and steam turbines, reporting tests. 2500 w. Trans Am Soc of Mech Engrs, No. 030—June, 1904. No. 62908.

Inclined Elevator.

The Inclined Elevator at Weehawken, New Jersey. Illustrated description of an electrically operated elevator, designed primarily to lift loaded wagons from the shore roads along the Hudson River, to the heights above. 2800 w. Eng Rec—April 30, 1904. No. 62523.

Lifting Gin.

Electric Lifting Gins. Illustrates and describes an inexpensive and expeditious method of lifting locomotives for repairs. 2300 w. Transport—May 13, 1904. No. 62762 A.

Rope Driving.

Advantages of Rope Transmission in Textile Plants. Frederick S. Greene. Abstract of a paper read before the N. England Cotton Mfrs. Assn. Sums up the advantages as far as they apply to textile plants, giving a comparison of cost. 1500 w. Ir Age—May 5, 1904. No. 62518.

Ropes.

Wire Ropes. G. W. Westgarth. Abstract of a paper before the Nat. Assn. of Colliery Mgrs. Reviews briefly the history of wire ropes, and the varieties made. Ills. 5800 w. Ir & Coal Trds Rev—April 29, 1904. No. 62611 A.

Tall Buildings.

The Power Plant of the Tall Office Building. James Hollis Wells. Deals with the engineering problems that enter into the construction, the elevators, steam plant, electric plant and wiring, etc. Ills. 4500 w. Trans Am Soc of Mech Engrs, No. 023—June, 1904. No. 62906 C.

The Power Plant of Tall Office Buildings. Reginald Pelham Bolton. An illustrated article giving an interesting discussion of the elevator systems and service, heating and ventilation, water supply, lighting systems, &c., in the tall buildings of New York City. 5500 w. Trans Am Soc of Mech Engrs, No. 027—June, 1904. No. 62907 C.

Wind Power.

The Importance of Windmills from an Economic Viewpoint (Les Moteurs à Vent et leur Importance au Point de Vue Economique). W. Geutch. An extensive discussion of the construction and application of wind motors and their practical applications. Serial. Part I. 5000 w. Bull Soc d'Encour—April 30, 1904. No. 62848 G.

STEAM ENGINEERING.

Boilers.

Boiler Design. A discussion opened by R. H. Sôule. 6300 w. Pro N. Y. R. R. Club—April 15, 1904. No. 62786.

The Management of Belleville Boilers at Sea. E. F. Baker. Gives the experience gained with these boilers on H. M. S. "Good Hope," and the treatment arising out of this experience, showing that by suitable treatment the Belleville boiler is satisfactory and economical. 7000 w. Engng—April 29, 1904. No. 62615 A.

Chimneys.

A Concrete-Steel Chimney Reinforced withT-Bars. Illustrates and describes a recently completed chimney at Zeigler, Ill., 154 feet 10 inches high, with an inside diameter of 6 feet. 800 w. Eng Rec—May 21, 1904. No. 62761.

The Building of a 255-Foot Chimney. J. W. Buzzell. Gives an illustrated general description of the chimney, the method of construction, method of testing materials, and of supplying stock to the masons, &c. 3500 w. Engr, U S A—May 15, 1904. No. 62697 C.

Engine Erection.

Preparation for the Erection of an Engine. W. T. Edwards. Deals with the foundations, the anchor bolts, flywheels, the handling of the bed plate, &c. Ills. 3200 w. Am Elect'n—May, 1904. No. 62504.

Setting Up a Vertical Engine. John F. Nagle. Directions concerning the proper method. 1800 w. Power—May, 1904. No. 62482 C.

Engine Test.

Test of the Engines of the Rochester Gas and Electric Company. Illustrations of the station, with report of tests. 2000 w. Power—May, 1904. No. 62478 C.

"Flash" Steam.

"Flash" Steam Generating Systems. An explanation of the principles of construction and operation and details of well-known types. 3000 w. Automobile—April 30, 1904. Serial. 1st part. No. 62456.

Fuel Economy.

Fuel Economy in Steam Plants. John B. C. Kershaw. A discussion from the chemist's point of view, considering the fuel supply, the combustion, and the waste gases. 4300 w. Cassier's Mag—May, 1904. No. 62783 B.

Fuels.

On Fuel Formulas. Considers a formula proposed by Mahler for obtaining the heat value of fuels which is exact enough for most purposes. 2000 w. Locomotive—Nov., 1903. No. 62429.

Furnaces.

Furnace Fittings for Steam Boilers. R. T. Strohm. Considers the materials composing the furnace, the grates, and the appliances for aiding the process of combustion. Ills. 2800 w. Am Elect'n—June, 1904. No. 62972.

Heating Surface.

The Value of Heating Surface. H. H. Vaughan. A study of this subject in locomotive practice, with general discussion. 10,000 w. Pro W. Ry Club—April 19, 1904. No. 62785 C.

Horse-Power.

Horse-Power of Steam Engines. Irving A. Taylor. Gives a simple method of arriving at an approximate result in computing the power from the dimensions and other apparent data. 800 w. Elec Wld & Engr—April 23, 1904. No. 62453.

Measuring the Indicator Diagram and Computing the Horse-Power of an Engine. H. H. Kelley. Describes methods employed by engineers. Ills. 1700 w. Engr, U S A—May 1, 1904. No. 62506 C.

Induced Draught.

Ellis and Eaves' System of Induced Draught Applied to Marine Boilers. Illustrated description. 2300 w. Engng—May 6, 1904. No. 62717 A.

Piping.

Practical Notes on Steam Piping (Praktische Erfahrungen und Mitteilungen über Rohrleitungen). Max Westphal. An extensive discussion of pipes, pipe joints, expansion joints, and other details; also flow of steam in pipes, etc. 5000 w. Zeitschr d Ver Deutscher Ing—April 23, 1904. No. 62803 D.

Pounding.

Some Causes and Remedies for Pounding in Engines. W. E. Crane. Calls attention to errors that cause this trouble, and way to remedy. Ills. 1200 w. Power—May, 1904. No. 62481 C.

Pulverized Coal.

The Use of Pulverized Coal for Fuel Under Steam Boilers. J. M. Sweeney. Reviews the attempts made to use this fuel, discussing the degree of success, and concluding that it has not yet been proved satisfactory. General discussion. Ills. 9500 w. Jour W Soc of Engrs—April, 1904. No. 62642 D.

Recording Apparatus.

The Control of Furnace Combustion. Illustrates and describes the Krell-Schultze apparatus for determining the resulting carbon-dioxide and other quantities. Refers also to other systems. 2000 w. Engng—May 6, 1904. No. 62715 A.

Separators.

Oil Separators for Exhaust and Condensed Steam (Oelabscheider für Abdampf und Kondensationswasser). H. Kühl. Illustrating and describing various forms of filters and diaphragm separators for the removal of lubricating oil from discharge steam. 2000 w. Zeitschr d Ver Deutscher Ing—April 16, 1904. No. 62800 D.

Smoke Prevention.

Notes on Burning Bituminous Coal. John M. Hartman. A study of this subject with an account of investigations of the problem of preventing smoke. General discussion. 8200 w. Pro Engrs' Club of Phila—April, 1904. No. 62635 D.

Speed Regulation.

Steam Engine Speed Regulation. J. J. M'Guire. Explains the purpose of the governor, describing types. 1500 w. Am Elect'n—May, 1904. No. 62502.

Superheating.

Experiments for Determining the Specific Heat of Superheated Steam. R. C. Carpenter. A report of experimental investigations and results. 2000 w. Sib Jour of Engng—May, 1904. No. 62913 C.

The Action of Superheated Steam in Reciprocating Engines (Das Verhalten Ueberhitzten Wasserdampfes in der Kolbenmaschine). Fritz Richter. Discussing tests on the experimental engine at Charlottenburg, including the calibration of instruments and graphical plotting of results. Three articles. 10,000 w. Zeitschr d Ver Deutscher Ing—April 30, May 7, 14, 1904. No. 62804 each D.

The Thermal Effect and the Practical Utility of Superheated Steam. Robert H. Smith. Discusses this subject, concluding the whole merit and utility of using superheated steam in engines lies in that it prevents condensation, and keeps the cylinder and ports dry. 2000 w. Elec Rev, Lond—May 13, 1904. No. 62769 A.

The Use of Superheated Steam and of Re-heaters in Compound Engines of Large Size. Lionel S. Marks. Gives results of 28 tests on 9 separate engines to determine the performance under different loads both with and without jacketing and reheating. Ills. 7500 w. Trans Am Soc of Mech Engrs, No. 021—June, 1904. No. 62904 D.

Traps.

Steam Traps. Walter W. Edwards. Illustrates and describes the various classes of steam traps according to their principle of operation. 2200 w. Engr, U S A—May 1, 1904. No. 62505 C.

Turbines.

Graphical Computations for the Steam Turbine (Die Berechnung der Dampfturbinen auf Zeichnerischer Grundlage). A. Koob. Showing the application of the temperature-entropy diagram to the practical problems of steam turbine design. Serial. Part I. 2500 w. Zeitschr d Ver Deutscher Ing—May 7, 1904. No. 62807 D.

Power Plant of the Yale & Towne Manufacturing Company. Illustrated description of a steam turbine installation in Stamford, Conn. 1200 w. Power—May, 1904. No. 62477 C.

The Parsons Steam Turbine (Der Parsons-Dampfturbine). Alfred Musil. Giving a historical review of the development of the Parsons turbine and an account of the latest construction; with especial reference to installations on the Continent. Two articles. 8000 w. Zeitschr d Oesterr Ing u Arch Ver—April 8, 15, 1904. No. 62823 each D.

Marine Steam Turbines. Reviews editorially the work already accomplished in adapting the steam turbine to marine use. 3000 w. Engng—May 6, 1904. No. 62720 A.

Multiple Impact Steam Turbine. A. M. Levin. Illustrates and describes a steam turbine of novel construction. 1000 w. Power—May, 1904. No. 62483 C.

New Steam Turbine Developments. W. L. R. Emmet. Confined principally to the work and experiences of the past year with the Curtis turbine. Gives the results of an interesting series of tests recently made upon one of the first of these turbines that was put into practical operation. 5000 w. Pro Engrs' Club of Phila —April, 1904. No. 62636 D.

Some Theoretical and Practical Considerations in Steam Turbine Work. Francis Hodgkinson. A discussion of special features of turbine work, which have a more or less intimate bearing upon the operation of a successful steam turbine. Considers types, giving illustrations, tests, &c. 10,000 w. Trans Am Soc of Mech Engrs, No. 031—June, 1904. No. 62909 D.

Steam Turbine Discs. Prof. Maurice F. FitzGerald. Discusses methods of calculating the stresses produced by rapid rotation in discs. 3500 w. Engr, Lond—May 13, 1904. No. 62774 A.

Tests of Steam Turbines at the Newport Station of the Old Colony Street Railway. A report of tests of Curtis turbines, with conclusions. 1000 w. Eng Rec—May 14, 1904. No. 62681.

The De Laval Steam Turbine. E. S. Lea, and E. Meden. An illustrated detailed description of the present type, with remarks on the difficult theoretical and practical problems encountered, the applications, &c. 3500 w. Trans Am Soc of Mech Engrs, No. 035—June, 1904. No. 62912.

The Steam Turbine. H. Boyd Brydon. An explanation of the laws under which the steam turbine operates, describing the principal types now on the market, the steam economy at present obtainable, and the applications of turbines as means of power production. 1600 w. Engr, U S A—May 15, 1904. Serial. 1st part. No. 62700.

The Steam Turbine. H. M. Gleason. Considers the advantages of the steam turbine over the reciprocating engine in general, and especially for the propulsion of ships. 1500 w. Sci Am Sup—April 30, 1904. No. 62536.

The Theory of Steam Turbines. Frank Foster. States the fundamental principles of turbines, describing briefly the different types, and considering the actions. Ills. 3000 w. Engng Rev—May, 1904. Serial. 1st part. No. 62957 B.

Vibrations.

The Vibrations of Crank Shafts (Schwingungen von Kurbelwellen). P. Roth. A mathematical investigation of the manner in which the forces upon engine shafts produce vibrations in the shaft; discussing especially a gas engine driving a dynamo. 2000 w. Zeitschr d Ver Deutscher Ing—April 16, 1904. No. 62801 D.

MISCELLANY.

Kites.

Professor Bell and His Kites. Waldon Fawcett. An illustrated account of the experimental work of Prof. Alexander Graham Bell in the field of aerial navigation through the medium of kites. 900 w. Elec Rev, N. Y.—May 21, 1904. No. 62790.

Mechanics.

The Physical Results of Modern Technical Mechanics (Naturwissenschaftliche Ergebnisse der Neueren Technischen Mechanik). A. Sommerfeld. An address showing the extent to which engineering investigations upon the properties of materials have influenced the study of mechanical physics. 6000 w. Zeitschr d Ver Deutscher Ing—April 30, 1904. No. 62805 D.

Observatory.

The Yerkes Observatory. Illustrates and describes this observatory, given the Univ. of Chicago, and located near William's Bay, Wisconsin. Deals with the mechanical details connected with the mounting and accessories. 2700 w. Engng—April 29, 1904. Serial. 1st part. No. 62613 A.

Sulphite Mill.

The Fenimore Sulphite Mill. Illustrated detailed description of a new plant of the Union Bag & Paper Company, near Sandy Hill, N. Y. 4500 w. Eng Rec—April 30, 1904. No. 62520.

Type-Composing.

Type-Composing and Distributing Machines. Illustrates and describes the Pulsometer Company's type-composing and justifying machine and a type-distributing machine. 2200 w. Engr, Lond—April 29, 1904. No. 62617 A.

MINING AND METALLURGY

COAL AND COKE.

Auchincloss.

The Auchincloss Colliery. Illustrated description of this new plant in the Wyoming-Lackawanna anthracite region. 2500 w. Eng & Min Jour—May 5, 1904. No. 62569.

Coal-Cutting.

British and American Coal-Cutting Machines. A. S. E. Ackermann. Abstract of a paper read before the Soc. of Engrs. Briefly reviews the history of these machines, describing British and American types, and giving statistics of interest. 5500 w. Ir & Coal Trds Rev—May 13, 1904. No. 62954 A.

Coal Mining.

The Ernest Plant of the Jefferson & Clearfield Coal & Iron Co., at Ernest, Indiana County, Pennsylvania. G. W. Harris. Illustrates and describes a development of coal properties exceeding in magnitude and originality anything hitherto attempted. 5000 w. Mines & Min—May, 1904. No. 62552 C.

Coke.

The Manufacture of Coke in the Hüssener Oven at the Clarence Ironworks, and Its Value in the Blast-furnace. C. Lowthian Bell. Read before the Iron & Steel Inst. Describes experiments made and the way the question of retort-oven coke was solved at Clarence, giving results. 4000 w. Ills. Ir & Coal Trds Rev—May 6, 1904. No. 62733 A.

Deep Mining.

The Application of Coal-Cutting Machines to Deep Mining. W. E. Garforth. Read at Nottingham Univ. College. An illustrated article comparing the method of working Longwall packgate by hand and by machine, stating the advantages and disadvantages and the qualifications a machine should possess. 6400 w. Ir & Coal Trds Rev—May 6, 1904. No. 62741 A.

Explosion.

The Harwick Mine Explosion. Report to the Commissioner of Mines by Board of Mine Inspectors who investigated immediately after the explosion. 7500 w. Mines & Min—May, 1904. No. 62555 C.

Faults.

The Great East or Symon Fault of the Shropshire Coalfield. Explains the term and describes the Coalbrookdale Coalfield, discussing the effect of the Symon fault upon lower productive coal measures. 2700 w. Col Guard—April 29, 1904. No. 62612 A.

New Zealand.

The Discovery and Progress of the Nightcaps Colliery. An illustrated article giving the history of this coalfield. 2700 w. N Z Mines Rec—March 16, 1904. No. 62402 B.

Pocahontas.

Industrial and Labor Conditions in the Pocahontas Coalfields. George L. Fowler. Mr. Fowler's second article discusses the labor condition of the district, including the negro question and the practical working of the company store. 4000 w. Engineering Magazine—June, 1904. No. 62-885 B.

Utah.

Mineral Resources of the Uinta Mountains. Charles P. Berkey. Reports meager mineralization, the richest resource known is in hydrocarbons. 1200 w. Eng & Min Jour—May 26, 1904. No. 62969.

West Virginia.

West Virginia Coal Mines. Information from the last annual report of James W. Paul, general mine inspector, concerning production, price, employees, wages, &c. 1700 w. Eng & Min Jour—May 12, 1904. No. 62648.

COPPER.

Arizona.

Notes on Geology of Mineral Creek District, Pinal County, Arizona. F. A. Gowing. Describes the topography, giving geologic facts, and describing copper and lead deposits. 3000 w. Min Rept—May 19, 1904. No. 62798.

The Clifton District, Arizona. An illustrated report of this district which has an output of about 60,000,000 lb. of copper a year. 2200 w. Eng & Min Jour—April 28, 1904. No. 62511.

The Copper-Deposits of the Kaibab Plateau, Arizona. E. P. Jennings. Describes the formation of the plateau, the ores, deposits, &c. 1000 w. Trans Am Inst of Min Engrs—Oct., 1903. No. 62941.

Australia.

English and Australian Copper Co. Donald Clark. Describes the works, processes and ores dealt with by this company. 2000 w. Aust Min Stand—April 7, 1904. Serial. 1st part. No. 62-703 B.

Concentration.

Concentration of Low-Grade Copper Ores. W. J. Adams. Gives results obtained in a series of tests made on the concentration of copper ores by the Elmore oil process. 1700 w. Min & Sci Pr—May 7, 1904. Serial. 1st part. No. 62661.

Deposits.

The Copper Deposits of Orange County, Vermont. Henry Lloyd Smith, and Philip S. Smith. Gives a summary of results of geological studies by students of Harvard University. 2200 w. Eng & Min Jour—April 28, 1904. No. 62510.

Impurities.

Relative Elimination of Impurities in Bessemerizing Copper-Matte. Allan Gibb. Discussion of the paper of W. Randolph Van Liew. 1700 w. Trans Am Inst of Min Engrs—Oct., 1903. No. 62942.

GOLD AND SILVER.

Alaska.

Unexplored Alaska. Information from a publication of the U. S. Geol. Survey, giving a story of a pioneer journey of 535 miles through Central Alaska, between the Yukon basin and the Arctic Ocean. 1100 w. Sci Am Sup—May 14, 1904. No. 62658.

British Columbia.

The Ore Deposits of Rossland, British Columbia. Edmund B. Kirby. Describes the geology of the deposits, the conclusions regarding their formation, the effect upon mining methods, &c. 4500 w. Can Min Rev—April 30, 1904. No. 62-498 B.

Canada.

The Alsek Mining District. W. M. Brook. An illustrated description of a new placer gold-field in the Northwest Territory of Canada, near the Alaska border, recently discovered. 800 w. Eng & Min Jour—May 12, 1904. No. 62649.

Colombia.

The Gold Deposits of Colombia (Les Alluvions Aurifères de la Colombie). A. Hutin. An account of the placer workings of San Carlos, Antioqua, Colombia. 1800 w. Revue Technique—April 10, 1904. No. 62815 D.

Concentration.

The Concentration of Gold and Silver in Iron-Bottoms. Myrick N. Bolles. Discussing the use of iron as an absorbent in separating the precious metals from mattes low in copper. Ills. 11300 w. Trans Am Inst of Min Engrs—Feb., 1904. No. 62927 C.

Crushing.

The Rise and Fall of Dry Crushing on the Hauraki Goldfield. Percy G. Morgan. Gives a general description of the dry-crushing practice, stating its advantages and disadvantages. 5600 w. N Z Mines Rec—March 16, 1904. No. 62-401 B.

Cyaniding.

Cyaniding Tailings at the Golden Jubilee Mine in Trinity Co., Cal. W. W. Merriam. A description of equipment, plant, treatment, &c. 13300 w. Cal Jour of Tech—May, 1904. No. 62627 C.

The Hendryx Cyanide Process. C. M. Fassett. An illustrated description of this process and statement of the claims made. 1200 w. Eng & Min Jour—May 5, 1904. No. 62567.

An Inexpensive Cyanide Plant. F. A. Malins. Describes a cheap and simple cyanide plant now in operation near Sheridan, Montana, giving details of working. Treats about fifty tons a day. 3000 w. Min Rept—May 5, 1904. No. 62559.

Deposits.

A Nevada Ore Deposit. Samuel C. Will. Describes a deposit of alabandite, the sulphide of manganese, carrying silver. 1100 w. Min & Sci Pr—May 14, 1904. No. 62794.

Mexico.

Notes on a Trip to White Oaks, New Mexico. E. Percy Smith and Leon Dominian. Illustrated description of this mining camp, with notes on its development and production. Gold placers and veins. 2000 w. Eng & Min Jour—May 19, 1904. No. 62749.

Mine Working.

The Method Used in Working the Silver-Lead Mines of Santa Eulalia, Chihuahua, Mexico. Edward G. Cahill. Explains the conditions of these mines when undertaken by modern engineers, and describes the successful working of a deep mining camp, most of the shafts being below the 1,500 foot level. 2500 w. Cal Jour of Tech—May, 1904. No. 62625 C.

Ore Deposits.

Genesis or Ore Deposits at the Royal Mine, Hodson, Cal. William Forstner. Illustrates and describes these deposits, explaining their probable formation. 2500 w. Min & Sci Pr—May 7, 1904. No. 62660.

Pan Amalgamation.

Pan Amalgamation at the "Minas del Tajo," Rosario, Mexico. A. E. Drucker. Gives results of extensive experimenting with pan-amalgamation, and valuable points in regard to the preventing and saving of "floured" quicksilver. 4000 w. Cal Jour of Tech—May, 1904. No. 62626 C.

Placers.

The Distribution of Placer Gold in Oregon. C. W. Washburne. Abstracted from the *Bulletin Univ. of Oregon.* Information concerning this region. 1100 w. Min & Sci Pr—April 30, 1904. No. 62562.

Sulphide-Smelting.

Sulphide-Smelting at the National Smelter of the Horseshoe Mining Co., Rapid City, S. D. Charles H. Fulton and Theodor Kuntzen. Describes the smelting of dry siliceous ores, extracting the gold and silver values in a matte of low copper-percentage. 3500 w. Trans Am Inst of Min Engrs—Feb., 1904. No. 62936.

Tonopah.

Tonopah Mining Camps. Arthur Lakes. Some notes on its location, the geological formations of the region, and the mines in operation. Ills. 3600 w. Mines & Min—May, 1904. No. 62554 C.

Veins.

The Jimtown Mining District and Golden Age Mine. Arthur Lakes. A typical example of the intersection on their dip of two vein systems, and their influence on mining. 3000 w. Ills. Mines & Min—May, 1904. No. 62557 C.

Yukon.

The Opportunities for Gold Dredging in the Yukon. C. B. Bolger. States conditions in this region and describes a dredger which worked successfully. 1000 w. Min & Sci Pr—May 14, 1904. No. 62795.

IRON AND STEEL.

Bessemer.

The Synthesis of Bessemer Steel. F. J. R. Corulla. Read before the Iron & Steel Inst. Considers the proper employment of manganese the key to the Bessemer process, and discusses the proper proportion for different mixtures, and the value of the Bessemer process. 4500 w. Ir & Coal Trds Rev—May 6, 1904. No. 62735 A.

Blast Furnaces.

Furnace Top Explosions. Frank C. Roberts. A discussion of the theories most generally accepted in explanation of these "slips" in blast furnaces burdened with a high percentage of fine ore. 3000 w. Ir Age—May 5, 1904. No. 62516.

Stock Distribution and Its Relation to the Life of a Blast Furnace Lining. David Baker. Discusses mechanical handling and its difficulties, the need of careful handling of coke, and attempts made to reduce the tuyere destruction. Ills. 2500 w. Trans Am Inst of Min Engrs—Feb., 1904. No. 62930.

The Thermal Efficiency of the Blast Furnace. W. J. Foster. Read before the Iron & Steel Inst. An examination of the furnace at Dorlaston; the materials used were chiefly silicates of iron, in the form of flue and tap cinders, and a small quantity of ferric oxide. Experiments and results. 5000 w. Ir & Coal Trds Rev—May 6, 1904. No. 62734 A.

The Use of High Percentages of Mesabi Iron-Ores in Coke Blast-Furnace Practice. W. A. Barrows, Jr. Gives the writer's experience in handling furnaces with mixtures containing large portions of Mesabi ores. Also discussion by Edward A. Uehling and others. 5800 w. Trans Am Inst of Min Engrs—Feb., 1904. No. 62932 C.

Canada.

The Coal and Iron Resources of the Dominion of Canada. An illustrated review of the resources, discussing their value, development, &c. 12800 w. Ir & Coal Trds Rev—May 6, 1904. No. 62743 A.

Deposits.

The Iron Ore Deposits in Southern

Utah. Fred Lerch. Information concerning the geology, the size and character of the ore bodies, quality of the ore and coal, facilities for cheap mining and the commercial prospects. Map. 2300 w. Ir Trd Rev—May 19, 1904. No. 62746.

Electric Smelting.

See Electrical Engineering, Electrochemistry.

Ferro-Silicon.

Explosions Produced by Ferro-Silicon. A. Dupre, and W. B. Lloyd. Gives the circumstances of the explosions, the cause, and precautions, to avoid future risk. 1400 w. Eng News—May 26, 1904. No. 62963.

Herrang.

The Manufacture of Pig-Iron from Briquettes at Herräng. Prof. Henry Louis. Read before the Iron & Steel Inst. Describes the mines, concentrating work, briquetting plant, blast furnace plant, and power station, giving general information. Ills. 5500 w. Ir & Coal Trds Rev—May 6, 1904. No. 62731 A.

Iron Making.

Influence of Raw Materials, Transport, and Labor on Iron Making Costs in Great Britain, United States, and Germany. An examination of the comparative conditions under which the principal industrial nations carry on their great industries. 7700 w. Ir & Coal Trds Rev—May 6, 1904. No. 62742 A.

Nitrogen.

Nitrogen in Iron and Steel. Ernst A. Sjostedt. A résumé of two articles in *Teknisk Tidskrift,* written by Hj. Braune and Clas Bolin, which should be of interest to furnace managers. 3000 w. Ir Age —May 5, 1904. No. 62519.

Ore Handling.

Modern Methods of Handling Iron Ore from Minnesota Mines to Pittsburg Furnaces. Charles H. Wright. Two-page plate, illustrations, and account of the ore-handling on the Great Lakes. 3500 w. Eng News—May 5, 1904. No. 62573.

The Movement of Iron Ore on the Great Lakes. Arthur J. Mason. An interesting illustrated description of the mining and ore handling methods in the Lake Superior region. General discussion. 5000 w. Jour W Soc of Engrs—April, 1904. No. 62640 D.

Rolling Mills.

Electrically Driven Rolling Mills. H. Koettgen. Condensed from a paper read at Duesseldorf before the Verein Deutscher Eisenhuettenleute. Discusses the problem of electric driving in its application to three-high mills, roll tables, reversing mills, &c. 4800 w. Ir Age—May 19, 1904. No. 62744.

Specifications.

Standard Specifications for Pig-Iron and Iron Products. Gives the specifications proposed by a sub-committee of the Am. Soc. for Testing Materials. 7000 w. Trans Am Inst of Min Engrs—Sept., 1904. No. 62928.

Statistics.

Some Statistics of the World's Iron and Steel Industries. William Pollard Digby. Statistics in regard to the respective supplies of iron ore in Germany and England as compared with the United States, showing the extent of the import and export trade in the United Kingdom, and the margin of profit of the iron industries. Also discussion. 8700 w. Jour Soc of Arts—May 6, 1904. No. 62621 A.

Steel.

Notes on the Production and Thermal Treatment of Steel in Large Masses. Cosmo Johns. Read before the Iron & Steel Inst. Describes briefly the practice of the works of Messrs. Vickers, Sons, & Maxim, Ltd., giving much valuable information. Ills. 4500 w. Ir & Coal Trds Rev—May 6, 1904. No. 62732 A.

Segregation and Diffusion in Steel. B. F. Weston. Considers the principle of segregation, and of diffusion, extreme cases, and results. 2000 w. Ir Age—May 19, 1904. No. 62745.

Steel Rails.

The Detection of the Finishing Temperatures of Steel Rails by the Thermo-Magnetic Selector. Albert Sauveur and Jasper Whiting. Describes a method seeming to fulfill all the requirements of efficiency in preventing the rolling of coarsely crystalline rails. Ills. 1600 w. Ir & Steel Mag—May, 1904. No. 62639 D.

See also Mechanical Engng., Materials.

MINING.

British Columbia.

The Ten Mile Creek Camp of the Nicola District. J. West Collis. An illustrated description of an interesting mineral belt, only needing transportation facilities to prove profitable. Workable coal seams, copper deposits, some gold and silver, &c. 2300 w. B C Min Rec—May, 1904. No. 62685 B.

Drills.

Rock-Drill Bits. T. H. Proske. Brief illustrated descriptions of various patterns. 800 w. Eng & Min Jour—May 5, 1904. No. 62568.

Dust.

Prevention of Dust in Mines. Charles B. Brodigan. From the *Pro. S. African Assn. of Engrs.* Describes the method of drilling used in constructing the Simplon Tunnel. 2500 w. N Z Mines Rec—March 16, 1904. No. 62403 B.

Excavations.

The Support of Excavations in the Witwatersrand Mines. T. Lane. Carter An account of the conditions of these mines, the prevailing practice, and cost of timbering. Ills. 1200 w. Eng & Min Jour—May 5, 1904. No. 62565.

Explosives.

The Effects of Cold and Frost upon Explosives (Effets du Froid et de la Gelée sur les Explosifs). H. Schmerber. Showing that the advantages due to the safe storage of frozen explosives are largely offset by the dangers of thawing. 1800 w. Génie Civil—May 7, 1904. No. 62828 D.

Exposition.

Mining Exhibits at the Louisiana Purchase Exposition. A. H. Storrs. Gives the location and general arrangement of the exhibits of the various States. 4200 w. Mines & Min—May, 1904. No. 62556 C.

Faults.

Faulting in the Globe District. Frederick Leslie Ransome. Abstracted from "The Geology of the Globe Copper District, Arizona." Illustrates and describes this faulted region. 1700 w. Eng & Min Jour—May 19, 1904. No. 62750.

Gases.

Gases in Metalliferous Mines. Abstract of a paper by Harry A. Lee, read before the Colorado Sci. Soc. An account of the occurrence of free nitrogen gas in a vein in Colorado, and its effects on those breathing it. 1500 w. Mines & Min—May, 1904. No. 62553 C.

Geogenesis.

Geogenesis and Some of Its Bearings on Economic Geology. Persifor Frazer. Considers the nebular theory and the new hypothesis propounded recently by Prof. Chamberlin. 4000 w. Trans Am Inst of Min Engrs—Feb., 1904. No. 62931.

Gravity Incline.

A Gravity Incline at the Antonio Mine in Cuba. E. M. Holmes. Illustrates and describes this new incline and its working. It seems to prove large cars superior to small ones in such work. 600 w. Eng News—May 12, 1904. No. 62664.

Laboratories.

See Industrial Economy.

Mine Traction.

Catches for Inclined Cable Railways (Fangvowichtungen au Steilen Förderbahnen). H. Gertner. Illustrating various forms of safety for use with inclined mine hoists, both for chain and wire cables. 1800 w. Glückauf—April 23, 1904. No. 62847 B.

Electric Traction for Mines. A. J. Bloemendal. Shows the advantages and good results obtained at the installations at the Szaboles coal mines. Ills. 2000 w. Trac & Trans—May, 1904. No. 62704 E.

Mining Engineers.

The American Mining Engineer. Albert R. Ledoux. Presidential address discussing to what influences the superior efficiency of American mining engineers is due. 5300 w. Trans Am Inst of Min Engrs—Feb., 1904. No. 62937.

Nevada.

The Silver Peak Region, Nevada. J. E. Spurr. An illustrated description of this arid district, with report of the silver and gold mines. 1700 w. Eng & Min Jour—May 12, 1904. No. 62647.

Oil.

The Volcanic Origin of Oil. Eugene Coste. Takes exception to views of other writers, and presents evidence in support of his views that the origin of oil is inorganic and the result of solfataric volcanic emanations. 3500 w. Trans Am Inst of Min Engrs—Feb., 1904. No. 62929.

Prospecting.

Sizing Up Prospects. Arthur Lakes. Examining untried country to determine whether or not it is advisable to prospect thoroughly. Ills. 1500 w. Mines & Min—May, 1904. No. 62558 C.

Quarries.

The Ancient Stone Quarries Beneath Paris. Information translated from the *Annales des Mines* concerning the extensive underground quarries which greatly impaired the stability of the surface in Paris. Ills. 1000 w. Quarry—May, 1904. No. 62595 A.

Queensland.

The Queensland Mining Industry. Review of 1903, with maps showing mining leases, tabulated statistics and reports. Gold, copper, tin and coal all show substantial increases. 16000 w. Queens Gov Min Jour—March 15, 1904. No. 62474 B.

Rand.

Electricity in Rand Mines. Sidney F. Walker. A report of the use made of electricity in South Africa. 1200 w. Aust Min Stand—March 31, 1904. No. 62702 B.

Separator.

A Magnetic Separator. W. R. Crane. An illustrated detailed description of the Cleveland-Knowles electro-magnetic separator used at Joplin. 2000 w. Min & Sci Pr—April 30, 1904. No. 62563.

Sizing.

The Plotting of Sizing-Tests. W. Spencer Hutchinson. Describes experiments undertaken primarily for the purpose of measuring the quality of work done in screening and sorting in American concentrating mills. 6000 w. Trans Am Inst of Min Engrs—Feb., 1904. No. 62938 C.

Stopes.

Ore Delivery from Stopes. E. L. Lefevre. Considers the meritorious systems of mill hole construction in general use. 2500 w. Min & Sci Pr—April 23, 1904. No. 62457.

Timbering.

Methods of Mining and Timbering in Large Ore Bodies in British Columbia and Michigan. Norman W. Parlee. Describes and discusses systems and their modifications as carried out in successful operation. Ills. 7400 w. Can Soc of Civ Engrs, Adv Proof—Feb. 25, 1904. No. 62433 D.

Mine Timbering in Section 16 of the Lake Superior Mining Company, Michigan. C. G. Campbell. Describes the location of the mine, the method of mining the ore, the management, &c., outlining the conditions, and describing the applications of different methods. Ills. 3500 w. Can Soc of Civ Engrs, Adv Proof—Feb. 25, 1904. No. 62435 D.

Wastes.

Wastes in Mining and Metallurgy. James Douglas. Address before the Mich. Col. of Mines. Notes examples of saving valuable elements in ore, and fuels in the present number. 1600 w. Eng & Min Jour —May 5, 1904. Serial. 1st part. No. 62564.

Winding.

Electric Winding. Gerald Hooghwinkel. Enumerates the most striking advantages of electric wire steam winding, describing the different systems employed on the Continent and in the United States, and giving details of a modern plant. 7500 w. Ir & Coad Trds Rev—May 13, 1904. No. 62952 A.

MISCELLANY.

New Constituent.

Troostite. Henry Cook Boynton. Read before the Iron and Steel Inst. Gives results of experiments presenting material which positively confirms the existence of troostite, with new facts related. 3000 w. Ir & Coal Trds Rev—May 6, 1904. No. 62738 A.

Platinum.

The Occurrence of Platinum in the Ural Mountains. Chester W. Purington. Gives citations from Russian authors, and recent papers on platinum, with translation from the *Bul. of Gold Min. Ind.*, St. Petersburg, "Concerning the Iss Platinum-bearing Region and the Distribution of Platinum in the Ural in General." Maps. 2000 w. Eng & Min Jour—May 5, 1904. Serial. 1st part. No. 62566.

Pyrrhotite.

Acid Making from Pyrrhotite. Ernest A. Sjostedt. Read before the Can. Min. Inst. Information and facts concerning the work done in treating the Sudbury pyrrhotite so as to recover the nickel, cobalt and copper, and to utilize the sulphur and iron contents. Ills. 4800 w. Can Min Rev—April 30, 1904. No. 62499 B.

Quicksilver.

A New Quicksilver Mining District. M. P. Kirk and J. W. Malcolmson. A report of the development work in Texas. 800 w. Eng & Min Jour—April 28, 1904. No. 62513.

Slimes.

Slime Treatment in the Joplin Region. W. R. Crane. An illustrated detailed description of the latest sludge mill built in the Galena district, showing the scheme of treatment. 1600 w. Eng & Min Jour—April 28, 1904. No. 62512.

Thermite.

The Production of Pure Metals and Metal Alloys by Means of Thermite. Dr. Alfred Gradenwitz. An explanation of the alumino-thermic manufacture of metals and alloys. 1200 w. Min Rept—May 19, 1904. No. 62799.

Zinc.

Zinc Ores in British Columbia. E. Jacobs. Gives a summary of the different deposits of zinc-bearing ores in the province, with remarks. 2000 w. Eng & Min Jour—May 26, 1904. No. 62970.

RAILWAY ENGINEERING

CONDUCTING TRANSPORTATION.

Accidents.

Accident Bulletin No. 10. Information from the last Bulletin issued by the Interstate Commerce Commission, with editorial comment. 4200 w. R R Gaz—April 29, 1904. No. 62509.

Car Distribution.

A Practical Method of Car Distribution. C. C. Riley. Read before the Car Accountants' Assn. Describes a system now in use on the Chicago Great Western. 2500 w. R R Gaz—May 27, 1904. No. 62967.

Car Interchange.

How Fairness is Secured in Car Interchange. From the Pittsburg *Commercial Gazette*. A discussion of former and present practice. 2200 w. Loc Engng—May, 1904. No. 62533 C.

Danger Signal.

Railroad Fusees. J. C. Ramage and Lewis Cheeseman, Sr. Considers the composition and mechanical construction of fusees from the standpoint of safety, and the requirement which actual service demands of a good fusee. 3000 w. R R Gaz —May 13, 1904. No. 62674.

Fast Run.

Record Run on the L. S. W. Railway. Charles Rous-Marten. An account of a run between Plymouth and London. 1700 w. Engr, Lond—April 29, 1904. No. 62616 A.

The Fast Run Record Beaten on the Michigan Central. Gives the schedule of the run made by the President's Special, from Niagara Falls, Ont., to Chicago, Ill., on April 27, 1904. 700 w. Ry Age—May 6, 1904. No. 62561.

Records.

Recent British Railway Records. Charles Rous-Marten. Discusses the services on the London and Northwestern Railway and the Great Western Railway. 1800 w. Engr, Lond—May 13, 1904. No. 62775 A.

Trans-Siberian.

The Trans-Siberian Railway (Le Chemin de Fer Transsiberién). E. Lemaire. A fully illustrated account of the history of the road and of the details of its commercial operation. Serial. Part I. 2500 w. 1 plate. Génie Civil—May 7, 1904. No. 62826 D.

Workmen's Trains.

Workmen's Trains in England. Facts and general information concerning the development of this service, the frequency of trains, number of passengers, rates, &c. 5700 w. Ry Age—May 20, 1904. No. 62793.

MOTIVE POWER AND EQUIPMENT.

Brakes.

Electric Car and Train Brakes. S. J. Kidder. Abstract of a paper before the Air-Brake Assn. Considers the various types of brakes brought out since the adoption of electric power for operating cars and trains. 3200 w. R R Gaz—May 13, 1904. No. 62672.

Higher Train Pipe Pressure for Passenger Service. J. P. Kelly. Comments on the tests of high pressure brakes conducted on the Central R. R. of New Jersey, and the results obtained, with other matters related to high-pressure service. 2800 w. R R Gaz—May 13, 1904. No. 62673.

Car Disinfection.

On the Disinfection of Passenger Carriages, of Cattle Trucks, and of Goods Wagons. Dr. De Rechter. Discusses the conclusions adopted by the XIIIth International Sanitary Congress, showing the great variety of methods used in different countries. 5800 w. Brit Int Ry Cong—April, 1904. No. 62471 E.

Counterbalancing.

The Computation of Counterweights for Multiple-Cylinder Locomotives (Die Berechnung der Gegengewichte bei Zwei, Drei und Viercylinder-Lokomotiven). J. Kempf. An examination of the action of the disturbing forces for various crank positions, and the extent to which they can be balanced. Serial. Part I. 3000 w. Glasers Annalen—May 1, 1904. No. 62832 D.

Couplings.

Automatic Couplings for Railway Rolling Stock. Mr. Sauer. Abstract translation of a report of a series of trials made by Messrs. Fried. Krupp, of Essen, on Feb. 12, 1903, with illustrations of details of construction of automatic couplings. 6600 w. Bul Int Ry Cong—April, 1904. No. 62473 E.

Equipment.

New Passenger Equipment for the London & Northwestern Railway. Illustrated detailed description of recently built cars, among them two royal saloon cars. 2500 w. Ry Age—May 20, 1904. No. 62792.

Firing.

Firing Locomotives. F. R. Wadleigh. Instructions aiming to cover the vital points and to expose clearly the work required of the fireman. 2000 w. R R Gaz —May 13, 1904. No. 62671.

Freight Cars.

The New Fifty-Ton Freight Cars of the Douai Forge Company (Les Récents Wagons de 50-Tonnes Construits par les Forges de Douai). Col. Fix. Illustrating recent heavy freight cars for the French railways. 2500 w. Revue Technique—April 25, 1904. No. 62817 D.

Locomotives.

A Michigan Central 4-4-2. Illustration, with description of an Atlantic type passenger engine. 700 w. Ry & Loc Engng—May, 1904. No. 62530 C.

British Locomotives in 1903. Charles Rous-Marten. Remarks on the design and work of new types on the fifteen leading railways of Great Britain. 5400 w. Bul Int Ry Cong—April, 1904. No. 62472 E.

Cole's 4-Cylinder Balanced Compound Locomotive. Illustration, with description of an interesting engine which will form a part of the exhibit of the N. Y. C. & H. R. R. R. at St. Louis. 500 w. Am Engr & R R Jour—May, 1904. No. 62463 C.

English Three-Cylinder Compound on the Midland. Illustrated description of an engine which works the express passenger trains between Leeds and Carlisle. 700 w. Loc Engng—May, 1904. No. 62532 C.

Locomotive Engine Details, Great Western Railway. Illustrations, with principal dimensions. 200 w. Engr, Lond—May 13, 1904. No. 62778 A.

Maintenance of Metallic Packing on Locomotives. P. A. C. King. Discusses the treatment packings should receive. 2000 w. Am Engr & R R Jour—May, 1904. No. 62466 C.

Mallet Articulated Compound for the Baltimore & Ohio. Illustrated description of a type extensively used in Europe, particularly adapted to heavy freight service on many grades with sharp curves. Inset. 1000 w. R R Gaz—May 27, 1904. No. 62968.

New Express Engines—Great Central Railway. Charles Rous-Marten. Illustration, with description of one of four new express engines of large and powerful type. These engines differ in important details, and are introduced for comparison with the view of determining which gives the best results. 3500 w. Engr, Lond—May 6, 1904. No. 62726 A.

New York Central 4-6-2 Engine. Illustration, with description of the heaviest type of passenger engine on this road. 1000 w. Loc Engng—May, 1904. No. 62531 C.

Pacific Type (4-6-2) Locomotives for the Michigan Central. Illustrated description of heavy locomotives for passenger service. 700 w. R R Gaz—April 29, 1904. No. 62508.

Road Tests of Consolidation Freight Locomotives. E. A. Hitchcock. A report of trials made, showing the engine performance, and also the losses incurred for the particular conditions encountered. 4500 w. Trans Am Soc of Mech Engr, No. 033—June, 1904. No. 62911 C.

Some Details of a Very Heavy Locomotive. Illustrates and describes details of the running gear of the 2-10-2 (Santa Fe) type, built for the Atchison, Topeka & Santa Fe Ry. 500 w. Am Engr & R R Jour—May, 1904. No. 62465 C.

Some Features of the Modern Locomotive. W. F. M. Goss. Extract from an address delivered before the Am. Soc. of Mech. Engrs. Discusses the limit of power and of draw-bar pull, boiler modifications, steam pressure, superheating, &c. 3300 w. Eng News—May 5, 1904. No. 62572.

Tank Locomotive for Heavy Suburban Traffic; Lancashire and Yorkshire Railway. Illustrated detailed description of a very powerful suburban locomotive. 600 w. Engng—May 6, 1904. No. 62719 A.

The New Locomotives of the Paris Belt Line (Les Nouvelles Locomotives au Chemin de Fer de la Petite Ceinture de Paris). J. Koechlin. Illustrating and describing recent tandem compound locomotives for local passenger service. 6000 w. 4 plates. Rev Gen des Chem de Fer—May, 1904. No. 62850 H.

Locomotive Testing.

Locomotive Testing Plant at the Louisiana Purchase Exposition. Information from Bulletin No. 2 of the Pennsylvania Railroad, which describes the plant, giving illustrations. 2000 w. Ry Age—May 13, 1904. No. 62690.

Locomotive Testing Plant at Swindon. A detailed description of this machine. 1000 w. Engr, Lond—April 22, 1904. No. 62423 A.

Locomotive Work.

Locomotive Work on the Great Western Railway. A brief review, with report of a recent run from Bristol to London on the train known as the "Flyer." 2000 w. Engng—April 29, 1904. No. 62614 A.

Railway Automobiles.

See Mechanical Engineering, Automobiles.

Suburban Cars.

Side-Door Steel Suburban Cars for the Illinois Central Railroad. Illustrated detailed description, with statement of the advantages. 3500 w. St Ry Jour—April 30, 1904. No. 62496 C.

NEW PROJECTS.

Cut-Off.

Railroading Across Great Salt Lake. Herbert I. Bennett. An illustrated article on the Ogden-Lucin cut-off on the Central Pacific division of the Southern Pacific. The most noteworthy achievement in bridge-and-fill work ever accomplished. 1500 w. Sci Am Sup—May 21, 1904. No. 62748.

PERMANENT WAY AND BUILDINGS.

Crossings.

Some Modern Appliances Connected with Railway Crossings and Points. Owen R. Williams. Describes and considers some appliances in regard to railway points and crossings, stating the reasons why they are needed, the qualities they should possess, &c. 3000 w. 3 plates. Trans Inst of Engrs & Shipbldrs in Scotland—April 26, 1904. No. 62619 D.

Location.

Railway Location in Victoria, Australia. D. M. Fraser. Deals with the application of the principles of economic railway location, as developed by A. M. Wellington, to the conditions in Australia. Chiefly considers light traffic railways. 13300 w. Eng News—May 12, 1904. No. 62668.

The Location of the Knoxville, La Follette and Jellico Railroad, of the Louisville and Nashville System. Discussion of W. D. Taylor's paper on this subject. 12800 w. Pro Am Soc of Civ Engrs—April, 1904. No. 62444 E.

Machine Tools.

Special Machine Tools for Locomotive Shops. Joseph Horner. Illustrates and describes examples from British and Continental practice. 3700 w. Cassier's Mag—May, 1904. No. 62784 B.

Manchuria.

The Eastern Railway of China (Die Chinesische Ostbahn), with map of the Manchurian Section of the Trans-Siberian Railway, showing its branches and the development of the country traversed. 1000 w. Glasers Annalen—April 15, 1904. No. 62830 D.

Momentum Grades.

Momentum Grades: Some Comments on Their Literature and Their Probable Future Use. W. D. Taylor. Revises briefly papers giving information on this subject, with comments. 4800 w. Eng News—April 28, 1904. No. 62492.

Repairing.

Power Plant for Use in Track Repairing (Application de la Force Mécanique aux Travaux de Renouvellement des Vorés). M. Regnoul. Illustrating a portable electric generating plant for use with electric tools for repair work on any part of a railway line. 4500 w. Rev Gen des Chem de Fer—May, 1904. No. 62849 H.

Shops.

Shop Management, Organization and Methods. H. A. Lyddon. Read before the Northwest Ry Club. On the importance of having men of character and ability as heads of the various departments, discussing the present conditions. 4400 w. Ry & Engng Rev—May 13, 1904. No. 62696.

Signalling.

A Novel Block or Telephone Signal System. Describes a block or telephone signal system independent in itself, invented by Edward Rowe. 1400 w. Sci Am Sup—May 14, 1904. No. 62656.

See Electrical Engineering, Communication.

Stations.

Passenger Stations of the Illinois Central. Illustrations of 15 stations representing the most characteristic types in use on this road, with notes. 1200 w. R R Gaz—May 20, 1904. No. 62752.

Track Elevation.

Track Elevation of the Pennsylvania in Newark, N. J. An illustrated detailed description of the work of elevating about three miles of track without interrupting the heavy traffic. 2800 w. R R Gaz—May 6, 1904. No. 62575.

Turntable.

A Turntable of New Design. Illustrated description of an exhibit at the St. Louis World's Fair, of a design embodying several new features. 700 w. Ry & Engng Rev—May 21, 1904. No. 62796.

TRAFFIC.

Rates.

English and American Rates. George S. Gibb, in the London *Times*. A comparison, giving information not before available. Also editorial. 2800 w. R R Gaz—May 27, 1904. No. 62965.

Royal Docks.

The Great Central's Fish Traffic. An illustrated article describing the important traffic from the royal docks at Great Grimsby, and giving an account of the development. 4500 w. Ry Age—May 13, 1904. No. 62689.

MISCELLANY.

Apprentice Schools.

Apprentice Schools on English Railways. An interesting account of the instruction provided by English railways for apprentices. 2500 w. Am Engr & R R Jour—May, 1904. Serial. 1st part. No. 62464 C.

Mail Service.

Railway Mail Service in 1856. John Kirby. A brief history of the growth of the railway postal service between Toledo and Chicago in 1856, compared with the service between New York and Chicago at the present time. 1200 w. Ry Age—June 10, 1904. No. 63199.

Midland Railway.

Diamond Jubilee of the Midland Railway. W. B. Paley. A brief review of the history. 2300 w. R R Gaz—June 3, 1904. No. 63106.

The Diamond Jubilee of the Midland Railway. A condensed review of the history of this English railway. 1600 w. Engr, Lond—May 20, 1904. No. 63016 A.

N. Y., N. H. and H. R. R.

The Upbuilding of a Railroad System. Clarence Deeming. Begins an interesting review of the history of the New York & New Haven Railroad. 5500 w. R R Gaz—April 29, 1904. Serial. 1st part. No. 62507.

Timber.

Timber Treatment and Timber Treating Plants. Walter W. Curtis. Reviews the history of timber preservation, the methods, with statement of comparative costs, and other information. General discussion follows. 10700 w. Pro N Y R R Club—April 15, 1904. No. 62787.

STREET AND ELECTRIC RAILWAYS

Accidents.

Street Railway Accidents—Their Cause, Prevention and Adjustment. Henry W. Brooks, Jr. Discusses the subject in detail. 6500 w. St Ry Jour—May 14, 1904. No. 62646 C.

Brakes.

Electric Car and Tram Brakes. S. J. Kidder. From a paper read before the Air Brake Ass'n. Reviews briefly the various systems that have been tried. 3000 w. St Ry Rev—May 20, 1904. No. 62921 C.

Cable Railway.

The Cable Incline Railway at Hohensyburg (Die Drahtseil-Bergbahn nach der Hohensyburg). Otto Armknecht. Description of electrically driven incline cable road, 445 metres long, with a rise of 93 metres, near Hörde, Westphalia. Serial, Part I. 2500 w. Elektrotech Zeitschr—May 12, 1904. No. 62862 B.

California.

The Key Route Electric Railway Power Plant, Oakland, Cal. An illustrated detailed description of the plant provided for the San Francisco, Oakland & San Josè Railway, which has many features of interest. 2700 w. Eng Rec—May 7, 1904. No. 62578.

The Los Angeles & Redondo Railway. An illustrated description of an electric interurban system that was formerly a steam road. 4000 w. St Ry Jour—April 30, 1904. No. 62495 C.

The Street Railway and Ferry Systems of Oakland, Cal. Illustrated description. 900 w. St Ry Rev—May 20, 1904. No. 62918 C.

Car Houses.

Electric Railway Car Houses—Construction and Hazards. Ralph Swetland. From Bulletin of the Committee of the Nat. Fire Pro. Assn. Suggestions for safety as given in recently adopted requirements of the New England Insurance Exchange. 6000 w. St Ry Jour—May 21, 1904. No. 62903 C.

Colorado.

Trinidad Electric Railroad Co. Illustrated description of the plant, roadbed, and rolling stock of the new urban and interurban lines recently put into operation in Trinidad, Colorado. 1000 w. St Ry Rev—May 20, 1904. No. 62917 C.

Competition.

Railway and Tramway Competition in England. W. M. Acworth. A discussion of conditions in England, the reasons why competition has not become serious sooner, the policy to be adopted, &c. 2300 w. Ry Age—May 20, 1904. No. 62791.

Concrete Sub-Station.

The New Parkville Concrete Sub-station of the Brooklyn Rapid Transit Company. Illustrated description. 2000 w. St Ry Jour—May 7, 1904. No. 62583 C.

Control.

A Regenerative System of Tramcar Control. Illustrates and describes two recent British patents by J. S. Raworth for improvements in motors and regulating devices for electrically propelled vehicles. 2800 w. Elect'n, Lond—April 29, 1904. No. 62609 A.

Delays.

New System of Checking Car Service for Delays—Brooklyn Rapid Transit Company. Explains an effective system of reporting car service, with special reference to the tracing of irregularities of headway. 2000 w. St Ry Jour—May 7, 1904. No. 62582 C.

Despatching.

Train Despatching on the Rochester & Eastern Rapid Railway. An illustrated article giving interesting particulars regarding the telephone despatching system, and the apparatus employed. 2000 w. St Ry Jour—May 21, 1904. No. 62900 C.

Egypt.

A New Electric Railway in Alexandria, Egypt. An illustrated account of the electrification of the Alexandria & Ramleh Railway, and installation of electric traction upon the lines of the Alexandria Tramway Co. A high-voltage alternating-current transmission system with rotary converter sub-stations. 1700 w. St Ry Jour—May 7, 1904. No. 62580 C.

Electric Railways.

The Growth of an Electric Railway. L. E. Gould. Explains in a general manner the progress of an electric railway up to the date of its operation. 4000 w. St Ry Rev—May 20, 1904. Serial, 1st part. No. 62915 C.

Electrification.

Electric Traction on the Lancashire and Yorkshire Railway. An illustrated detailed description of the new service between Liverpool and Southport, and the changes made necessary in permanent way, rolling stock and equipment. 8600 w. Tram & Ry Wld—April 14, 1904. No. 62395 B.

Exposition Features.

Some of the Electric Railway Features

at the World's Fair, St. Louis. Winder Elwell Goldsborough. An illustrated article explaining the investigations to be carried out under the direction of the Electric Railway Test Commission. 1600 w. St Ry Jour—May 7, 1904. No. 62579 C.

Germany.

Financial Results of Electric Railway Operation in Germany. Gives particulars in regard to the profits made, cost of operating, fares charged, &c. The returns are less favorable than was anticipated. 2800 w. St Ry Jour—May 7, 1904. No. 62584 C.

Grounding.

The Grounding of the Neutral Point with Three-Phase Currents (Die Erdung des Neutralen Punktes bei Drehstromanlagen). Paul Humann. Discussing especially the losses due to the dielectric of the cable. 2000 w. Elektrotech Zeitschr—May 5, 1904. No. 62859 B.

High Speed.

Experiments in High-Speed Electric Traction on the Marienfelds-Zossen Line (Les Experiences de Traction Electrique Rapide sur la Ligne de Marienfelde-Zossen). Alfred Gradenwitz. An illustrated account of the experiments of 1901-1903, at speeds of 160 to 210 kilometres per April 15, 1904. No. 62841 D.

Interurban.

Practical Hints on Interurban Railway Operation. A. B. Herrick. Discusses some points in common practice that are not suited to interurban service. 2200 w. St Ry Jour—May 21, 1904. No. 62901 C.

Mountain Railway.

The Fayet-Chamouix Railway. Daniel Bellet. Outlines a plan for constructing a railway to the summit of Mont Blanc, and gives an illustrated detailed description of the Fayet-Chamonix electric railway, which connects the foot of Mont Blanc with the Paris-Lyons-Mediterranean System. 4500 w. Trac & Trans—May, 1904. No. 62705 E.

Mt. Vesuvius.

The New Mt. Vesuvius Electric Railway. Illustrated detailed description of the new railway from Naples to the base of the cable railway. The plans embrace the employment of ordinary and rack sections to be operated by electricity. 2000 w. St Ry Jour—May 7, 1904. No. 62581 C.

Narrow-Gage.

Narrow-Gage Road from Lausanne to Mondon. E. Guarini. Illustrated description of an interesting line in Switzerland. 1300 w. St Ry Rev—May 20, 1904. No. 62916 C.

New Hampshire.

Manchester Traction, Light & Power Co. Illustrates and describes the electrical power generation and distribution from the water powers along the Merrimac and Piscataquog Rivers. 3000 w. St Ry Rev—May 20, 1904. No. 62914 C.

Rail Conduction.

The Drop in Voltage in Alternating Traction Systems (Spannungsabfall von Wechselströmen in Eisenbahnschienen). Dr. H. Behn-Eschenburg. A discussion of the difficulties in using the rails as return conductors. 4500 w. Elektrotech Zeitschr—April 21, 1904. No. 62854 B.

Rail Joints.

Tramway Rail Joints. Discusses troubles with rail joints, their causes and remedies. 3800 w. Tram & Ry Wld—April 14, 1904. No. 62396 B.

St. Louis.

East St. Louis & Suburban Railway. Illustrating and describing the new power plant recently completed to replace several smaller plants of the consolidated companies. 2000 w. St Ry Rev—May 20, 1904. No. 62920 C.

Some Features of the East St. Louis & Suburban Railway. Brief illustrated description of this system, road and equipment, shops, &c. 2800 w. St. Ry Jour—May 14, 1904. No. 62645 C.

Testing.

Train Testing. Sydney W. Ashe. Considers such tests which are desirable to make when the car equipment is in an operative condition, such as insulation tests, motor capacity tests, speed time curves, &c. Ills. 2300 w. St Ry Jour—May 21, 1904. No. 62902 C.

Traction.

The Continuous-Current System and the Single-Phase System for Traction. H. M. Hobart. A defense of the continuous-current system is given in the present article. 2200 w. Elec Rev, Lond—April 29, 1904. Serial. 1st part. No. 62606 A.

Trolley Line.

The New Overhead Wiring of the Street Railways of Hanover (Die Neuerbaute Oberleitungsanlage der Strassenbahn Hannover). L. Liebenberg. A fully illustrated account of the wiring and feeders, including the arrangement for a number of intricate curves. 3000 w. Elektrotech Zeitschr—May 5, 1904. No. 62858 B.

Tube Railway.

The Great Northern and City Railway. H. C. Fyfe. A description of the line and power plant of the most recent tube railway of London. 3000 w. Engineering Magazine—June, 1904. No. 62881 B.

EXPLANATORY NOTE—THE ENGINEERING INDEX.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language,* together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. Certain journals, however, make large extra charges for back numbers. In such cases we may have to increase proportionately the normal charge given in the Index. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w,* a bi-weekly, *s-w,* a semi-weekly, *m,* a monthly, *b-m,* a bi-monthly, *t-m,* a tri-monthly, *qr,* a quarterly, *s-q,* semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* Boston.
American Electrician. *m.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Jl. of Science. *m.* New Haven, U.S.A.
American Machinist. *w.* New York.
American Shipbuilder. *w.* New York.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. d Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *qr.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Sydney.
Autocar. *w.* Coventry, England.
Automobile. *m.* New York.
Automobile Magazine. *m.* New York.
Automotor Journal. *w.* London.
Beton und Eisen. *qr.* Vienna.
Brick Builder. *m.* Boston.
British Architect. *w.* London.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bulletin American Iron and Steel Asso. *w.* Philadelphia, U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. Soc. Int. d Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bulletin Univ. of Kansas. *b-m.* Lawrence.
Bull. Inf. Railway Congress. *m.* Brussels.
California Jour. of Tech. *m.* Berkeley, Cal.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Montreal.
Canadian Mining Review. *m.* Ottawa.
Cassier's Magazine. *m.* New York.
Central Station. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *m.* Chicago.

Electrical Engineer. *w.* London.
Electrical Review. *m.* London.
Electrical Review. *w.* New York.
Electrical World and Engineer. *w.* New York.
Electric Club Journal. *m.* Pittsburg, Pa.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *w.* New York.
Electrochemical Industry. *m.* New York.
Electrochemist and Metallurgist. *w.* London.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Chicago.
Engineering. *w.* London.
Engineering and Mining Journal. *w.* New York.
Engineering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Engineering Review. *m.* London.
Eng. Soc. of Western Penna. *m.* Pittsburg, U.S.A.
Engineering Times. *m.* London.
Fire and Water. *w.* New York.
Foundry. *m.* Cleveland, U. S. A.
Gas Engineers' Mag. *m.* Birmingham.
Gas World. *w.* London.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e. d. Str. Ferr. *w.* Rome.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Ice and Refrigeration. *m.* New York.
Ill. Zeitschr. f. Klein u. Strassenbahnen. *s-m.* Berlin.
Ingenieria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron and Steel Metallurgist. *m.* Boston.
Iron and Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. Am. Foundrymen's Assoc. *m.* New York.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Journal of Sanitary Institute. *qr.* London.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery *b-m.* Fort Monroe, U.S.A
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, U.S.A.
Locomotive. *m.* Hartford, U. S. A
Locomotive Engineering. *m.* New York.
Machinery. *m.* New York.
Madrid Cientifico. *t-m.* Madrid.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U. S. A.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Metal Worker. *w.* New York.
Métallurgie. *w.* Paris.
Minero Mexicano. *w.* City of Mexico.
Minerva. *w.* Rome.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci Press. *w.* San Francisco.
Mining Reporter. *w.* Denver, U. S. A
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
Modern Machinery. *m.* Chicago.
Mouvement Maritime. *w.* Brussels.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *m.* New York.
Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Nineteenth Century. *m.* London.
North American Review. *m.* New York.
Oest. Wochenschr. f. d. Oeff. Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg- & Hüttenwesen. *w.* Vienna.
Ores and Metals. *w.* Denver, U. S. A.
Pacific Coast Miner. *w.* San Francisco.
Page's Magazine. *m.* London.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Proceedings Engineers' Club. *qr.* Philadelphia.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Progressive Age. *s-m.* New York.
Quarry. *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago.
Review of Reviews. *m.* London & New York.
Revista d Obras. Pub. *w.* Madrid.
Revista Tech. Ind. *m.* Barcelona.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Gen. des Sciences. *w.* Paris.
Revue Industrielle. *w.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Gen. d Ferrovie. *w.* Florence.
Rivista Marittima. *m.* Rome.
Schiffbau. *s-m.* Berlin.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Engng. *m.* Ithaca, N. Y.
Stahl und Eisen. *s-m.* Düsseldorf.
Stevens' Institute Indicator. *qr.* Hoboken, U.S.A.
Stone. *m.* New York.
Street Railway Journal. *m.* New York.
Street Railway Review. *m.* Chicago.
Tijds. v h Kljk. Inst. v Ing. *qr.* Hague.
Traction and Transmission. *m.* London.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Transport. *w.* London.
Wiener Bauindustrie Zeitung. *w.* Vienna.
World's Work. *m.* New York.
Yacht. *w.* Paris.
Zeitschr. d. Mitteleurop. Motorwagen Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a S.
Zeitschr. f. Elektrotechnik. *w.* Vienna.

THE
ENGINEERING MAGAZINE
"THE WORLD IS ITS FIELD"

VOL. XXVII. AUGUST, 1904. No. 5.

NATURAL CONDITIONS AFFECTING THE CONSTRUCTION OF THE PANAMA CANAL.

By Gen. Henry L. Abbot.

We are glad to be again the means of presenting to the engineering world General Abbot's most valuable studies of the conditions to be met in the building of the Panama Canal. There is no higher authority on the hydrology and climate of the Isthmus, and nowhere else such a fund of exact and exhaustive data as is at General Abbot's command. It is by the definite knowledge and the correct interpretation of these facts that the great key problems of the construction work must be decided—The Editors.

NOW that the completion of the canal has been definitely assumed by the United States, and the attention of American engineers and others is attracted to the numerous problems involved in the works of construction, it seems desirable to supplement my paper on the Regulation of the Chagres River, which appeared in THE ENGINEERING MAGAZINE for December, 1902, with a view not only to bringing these invaluable records of the New Company up to date, but also to considering some other matters of practical importance to those contemplating participation in the work.

Among these other matters is the volume, and especially the distribution, of rainfall in the different months of the year. As is well-known, there is a sharp division between the rainy and dry seasons; the respective volumes are shown in the following table which is a summary of the monthly observations of the officers of the Canal Company and of the Panama Railroad from the earliest dates up to the transfer of the property at the end of April, 1904. Figures in brackets denote the number of years covered by the records.

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Table I. Consolidated Records of Rainfall in Inches.

	Atlantic.		Interior Stations.					Pacific Coast.			
Month.	Colon. (33)	Bohio. (7)	Alhajuela. (4)	Gamboa. (21)	Gorgona. (3)	Bas Obispo. (10)	Culebra. (5)	Panama. (4)	Naos. (7)	Taboga. (3)	La Boca. (5)
Jan.	4.0	9.0	1.3	2.4	3.3	1.8	0.9	0.7	0.5	0.2	2.1
Feb.	1.4	1.8	0.3	0.7	0.6	0.4	0.2	0.7	0.1	0.0	0.1
Mar.	1.6	2.3	0.7	0.9	1.2	0.8	0.3	1.6	0.4	0.0	1.9
Apl.	4.2	5.3	4.9	3.5	2.4	2.7	2.0	2.8	1.7	0.8	4.0
May	12.1	13.3	11.7	10.9	11.6	10.9	12.0	7.6	4.8	6.3	9.2
June	13.4	12.6	12.3	9.6	9.3	11.7	10.2	7.9	5.5	8.2	7.1
July	16.7	17.1	14.7	10.3	13.3	8.8	7.6	7.6	4.3	6.2	9.5
Aug.	15.1	19.2	12.9	12.7	14.2	9.8	8.9	6.8	4.8	7.1	7.2
Sept.	12.6	16.6	11.8	10.9	13.5	12.2	9.1	7.5	7.4	7.3	6.7
Oct.	14.0	18.0	14.9	13.1	11.2	10.5	11.7	9.5	6.6	7.3	9.9
Nov.	20.9	20.3	16.1	12.2	10.4	10.6	11.3	11.6	6.3	4.1	10.1
Dec.	12.3	10.6	7.5	7.0	5.5	9.1	11.2	2.8	3.2	6.6	5.6
Year	128.3	146.1	109.1	94.2	96.4	89.3	85.3	66.8	45.5	54.0	73.4

To aid in estimating the number of rainy days probable in each month, a table giving a complete record for a few years, with their averages, seems to be preferable to one presenting simply averages for longer periods, since it reveals the annual variations. Such a table is the following, covering the last five years at stations where most work will be required. Each day in which rain fell is included. It would appear that the rainfall at Bohio is not only larger in volume but is also more frequent than at any other point of the canal line. Further in the interior, where are found the heaviest excavations, a safe monthly estimate would seem to be one week of rainy days and half an inch of rain in the dry season, and three weeks and twelve inches in the rainy season; but it must not be forgotten that on many of these days very little rain falls.

Table II. Number of Rainy Days Per Month.

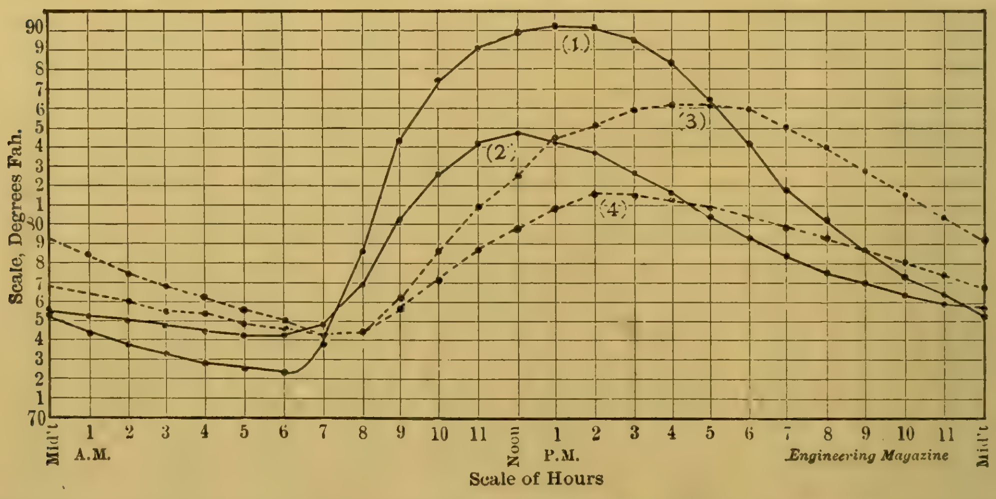
	COLON.						
Month.	1899.	1900.	1901.	1902.	1903.	1904.	Means.
January	19	11	13	19	9	17	15
February	12	4	4	5	5	7	6
March	4	5	6	9	12	7	7
April	3	4	5	14	11	17	9
May	17	17	15	20	20	..	18
June	18	22	17	17	16	..	18
July	25	23	22	19	18	..	21
August	21	24	25	13	23	..	21
September	20	18	21	20	23	..	20
October	15	23	26	20	18	..	20
November	15	25	28	23	26	..	23
December	13	14	23	15	25	..	18
Year	182	190	205	194	206	..	196

TABLE II. NUMBER OF RAINY DAYS PER MONTH.—*Continued.*

Month.	1899.	1900.	1901.	1902.	1903.	1904.	Means.
BOHIO.							
January	23	17	11	24	10	26	19
February	18	5	8	3	4	11	8
March	13	8	11	5	10	16	11
April	7	6	11	14	10	20	11
May	17	27	28	(23)	20	..	23
June	26	27	22	20	19	..	23
July	25	31	30	20	21	..	25
August	30	29	29	21	27	..	27
September	25	28	27	20	26	..	25
October	21	30	29	24	28	..	26
November	19	28	30	21	30	..	26
December	20	20	22	16	30	..	22
Year	244	256	258	188	235	..	246
ALHAJUELA.							
January	..	8	5	(7)	4	12	7
February	..	1	1	2	(2)	2	2
March	..	1	3	3	3	5	5
April	..	9	5	16	3	10	9
May	..	18	25	(22)	22	..	22
June	..	24	22	27	24	..	24
July	20	26	21	23	29	..	24
August	21	22	25	20	27	..	23
September	20	19	23	18	18	..	20
October	21	20	16	26	23	..	23
November	21	20	27	24	27	..	24
December	11	10	16	12	25	..	15
Year	..	178	199	200	207	..	198
GAMBOA.							
January	13	7	5	17	6	16	11
February	8	2	2	3	2	2	3
March	7	2	1	13	3	10	6
April	6	9	5	22	6	20	11
May	11	18	20	(18)	23	..	18
June	23	23	21	16	19	..	20
July	19	22	21	20	24	..	21
August	21	21	21	19	26	..	22
September	18	15	16	21	23	..	19
October	14	24	25	25	22	..	22
November	16	24	27	26	25	..	24
December	10	8	16	10	23	..	13
Year	166	175	180	210	204	....	190
LA BOCA.							
January	..	2	(6)	8	5	9	6
February	..	0	(1)	1	0	3	1
March	..	0	(4)	4	1	10	4
April	..	5	(7)	6	5	13	7
May	..	6	14	12	18	..	12
June	..	17	18	7	9	..	13
July	..	9	17	8	24	..	15
August	..	10	16	21	21	..	17
September	20	..	19	14	15	..	17
October	18	..	22	20	21	..	20
November	16	..	19	17	20	..	18
December	6	..	11	7	19	..	11
Year	109		154	125	158	..	141

Many inquiries are made about the temperature of the Isthmus. The monthly averages hardly vary throughout the year along the line of the canal. Well distributed observations covering 309 months indicate a variation of only 2.7 degrees Fah. between the coolest month (January, 78.3 degrees) and the hottest month (June, 81.0 degrees). The annual mean is 79.7 degrees.

A similar uniformity does not appear in the hourly diurnal variations. They show well marked difference in the rainy and dry seasons, and also in the interior and on the coast. Five years of observations with self-recording thermometers at Alhajuela and at La Boca have made these differences known with precision, and as they are not without importance in regulating the hours of work the following table has been prepared to indicate them; in it "maxima" and "minima" refer to absolute extremes as recorded during the entire period under each heading. As appears from Table II, the months of January, February, March, and April during these five years should be accounted as dry, and the other months as rainy. The characteristic differences between seasons are largely due to different hygrometric conditions of the atmosphere, which affect radiations from the sun and specially from the earth. This is made manifest when temperature curves of exceptionally dry or rainy months are compared with the average for their season, and for this reason the means for March and November are added to the following table. They are the extreme months in respect to precipitation, and show in a slightly exaggerated



MEAN DAILY TEMPERATURE IN DEGREES F. FIVE-YEAR MEANS OF EXTREME DRY AND RAINY MONTHS. PLOTTED FROM TABLE III.

1, Alhajuela in March; 2. Alhajuela in November; 3, La Boca in March; 4, La Boca in November. Alhajuela is on the Upper Chagres, 144 feet above mean tide; La Boca is on the Bay of Panama, at about sea level.

form the characteristic temperature differences between seasons, as will be noted by comparing the figures in the table. These extreme types have been selected to be shown on the plate, where they present the normal differences, due to season and locality, so clearly to the eye that little need be added in words. The table, representing over 80,000 readings of the thermometer, certainly demonstrates that although the monthly mean temperatures are sensibly constant throughout the Isthmus, the coolest and hottest hours of the day occur later near the Pacific coast than in the interior; and that during the dry season the daily range is much greater, and the hours of extreme heat are decidedly later, than in the season of rains. In the table asterisks indicate points of maxima and minima.

TABLE III. FIVE-YEAR HOURLY VARIATIONS IN TEMPERATURE, IN DEGREES FAH.

	DRY SEASON.		RAINY SEASON.		EXTREME MONTHS.			
Hour.	Alhajuela.	La Boca.	Alhajuela.	La Boca.	Alhajuela.		La Boca.	
					March.	Nov.	March.	Nov.
1 A. M.	74.9	78.2	75.4	77.6	74.4	75.3	78.4	76.4
2 “	74.4	77.5	75.2	77.1	73.7	75.1	77.5	76.0
3 “	73.8	76.8	74.7	76.6	73.2	74.8	76.8	75.5
4 “	73.4	76.2	74.4	76.2	72.9	74.5	76.1	75.2
5 “	73.0	75.7	74.3	75.9	72.5	74.3	75.5	74.9
6 “	72.8*	75.2	74.2*	75.5	72.3*	74.2*	74.9	74.6
7 “	74.3	74.6*	75.4	75.2*	73.8	74.9	74.2*	74.3*
8 “	78.8	74.7	76.3	75.2*	78.7	77.1	74.5	74.6
9 “	83.4	76.3	81.5	77.1	84.4	80.3	76.1	75.7
10 “	85.9	78.5	83.8	78.8	87.5	82.7	78.6	77.3
11 “	87.4	80.6	85.2	79.2	89.1	84.2	80.9	78.8
Noon	82.2	82.0	85.7*	81.6	90.0	84.7*	82.5	79.9
1 P. M.	88.3	83.4	85.4	82.6	90.4*	84.4	84.6	80.9
2 “	88.5*	84.5	84.5	83.2*	90.2	83.7	85.2	81.5
3 “	87.9	85.3	83.6	83.2*	89.6	82.7	85.9	81.6*
4 “	86.9	85.5*	82.5	82.8	88.3	81.6	86.1*	81.5
5 “	85.1	85.4	81.4	82.4	86.4	80.5	86.1*	80.9
6 “	83.1	85.1	80.0	81.8	84.1	79.2	85.9	80.4
7 “	81.1	84.3	79.0	81.4	81.8	78.3	85.1	79.8
8 “	79.7	83.4	78.0	80.8	80.2	77.5	84.0	79.3
9 “	78.2	82.2	77.3	80.1	78.7	77.0	82.6	78.6
10 “	77.3	81.2	76.8	79.6	77.4	76.4	81.6	78.0
11 “	76.4	80.1	76.2	78.8	76.3	76.0	80.4	77.4
Midnight	75.7	79.7	75.7	78.2	75.4	75.6	79.3	76.9
Means	80.4	80.3	79.0	79.2	80.9	78.5	80.5	77.9
Maxima	98.2	95.4	96.6	91.0	97.4	91.9	86.9	88.2
Minima	63.8	68.0	66.0	68.0	63.8	69.3	68.0	69.1

The health question, during construction, is one of the important elements of the canal problem. While no one will claim that the climate of the Isthmus is salubrious, it is certain that much wild exaggeration has been circulated, in great part founded on the experience of ill-acclimated laborers engaged in excavating surface soil for the railroad or for the canal. Fortunately most of the work on the latter has now reached a level below the poisonous emanations of decaying organic matter, and during recent years the percentage of disease and mortality has not exceeded that on large works in any country. The actual facts are set forth in the following table prepared from his official records by Dr. Lacroisade, for many years the medical director of the fine Company Hospital situated on the heights above the city of Panama. He insists that the disease most to be dreaded, yellow fever, is not endemic on the Isthmus and, as in the Southern States, may be excluded by proper precautionary measures. The table itself is encouraging, since the mean percentages in the three epochs show nearly constant values for the diseases of Europe, and a great reduction for diseases due to the climate, under the improved conditions of the later work.

Table IV. Official Health Statistics of the Panama Canal.

Years.	PERCENTAGE OF DISEASE.				PERCENTAGE OF MORTALITY.		
	Effective Force Employed.	Diseases of Europe.	Diseases Due to Climate.	Total.	Diseases of Europe.	Diseases Due to Climate.	Total.
			OLD COMPANY.				
1881	928	21.02	42.03	63.04	1.41	4.74	6.68
1882	1,910	18.85	47.64	66.69	3.21	4.39	6.60
1883	6,267	23.24	42.62	65.86	3.20	4.46	6.66
1884	17,615	27.58	36.95	64.57	2.58	4.08	6.66
1885	15,215	11.93	49.14	61.07	1.73	3.73	5.52
1886	14,935	14.01	43.88	57.89	1.67	3.43	5.10
1887	16,217	21.83	39.25	61.07	3.22	3.99	6.21
1888	13,725	12.17	40.46	52.63	1.81	2.54	4.35
Means ..	10,854	18.83	42.75	62.58	3.05	3.92	5.97
			RECEIVER.				
1889	1,826	.....	.....	.....	....	....	....
1890	about 800.	.....	.....	.....	....	....	....
1891		.....	.....	.....	....	....	....
1892		.....	.....	.....	....	....	....
1893		.....	.....	.....	....	....	....
1894		.....	.....	.....	....	....	....
Means ..	971	.....	.....	49.68	....	....	2.88
			NEW COMPANY.				
1895	1,225	.....	.....	49.96	2.05	0.89	2.94
1896	3,715	.....	.....	39.91	2.08	0.84	2.92
1897	3,980	.....	.....	51.85	1.99	1.00	2.99
1898	3,400	28.26	13.65	41.91	1.76	0.27	2.03
1899	2,500	19.76	5.84	25.60	2.24	0.12	2.36
1900	2,000	17.05	8.50	25.55	3.00	0.25	3.25
1901	2,000	18.60	6.85	25.45	1.55	0.20	1.75
Means ..	2,703	20.92	8.71	37.17	2.10	0.51	2.61

The relative danger of earthquake disturbances on the different routes suggested for an Isthmian canal has naturally attracted the attention of engineers. To secure definite information as to this matter two delicate seismographs were established at the Company Hospital near Panama in September, 1900, and the record is continuous since that date, covering forty-four months. The register shows seven slight tremors, four light shocks, and no severe shocks, the total duration of the disturbances being less than half a minute. It fortunately happened that the well equipped Institute Fisico-Geografico, under the direction of Monsieur Pittier, situated at San Jose de Costa Rica about sixty miles from the projected locks of the eastern division of the Nicaragua Canal route, instituted a similar series of observations in January, 1901, the results of which have been published in the U. S. Monthly Weather Review. These simultaneous records now cover thirty-seven of the forty-four months registered at Panama, and show in them forty-one slight tremors, eighty-nine light shocks, and thirty-seven severe shocks, the total duration of the earth motion being more than sixteen minutes. The fact that the Isthmus of Panama is much more stable than the region traversed by the rival route, and hence is less exposed to dangers from earthquakes, is thus established beyond cavil.

It only remains to bring up to date the records concerning the Chagres river contained in THE ENGINEERING MAGAZINE for December, 1902. The observations of the New Canal Company have continued without interruption to the end of April, 1904; and the following figures complete Table I of the Appendix.*

NUMBER AND DURATION OF RISES AT GAMBOA EXCEEDING 10 FEET ABOVE THE LOW-WATER STAGE, THE GREATEST HEIGHT IN FEET ABOVE LOW WATER, AND THE LOCAL RAINFALL IN INCHES.

Month.	Rises.	Hours.	Feet.	Rain.
		1902.		
Sept. ..	0	0	7.3	8.9
Oct. ...	2	15	16.4	12.9
Nov. ..	1	7	11.8	14.4
Dec. ...	0	0	6.1	2.2
		1903.		
Jan. ...	0	0	2.4	0.7
Feb. ...	0	0	4.1	0.1
Mar. ..	0	0	0.6	0.3
Apl. ...	0	0	1.3	0.4
May ..	0	0	5.7	11.1
June ..	1	2	10.1	11.1
July ...	1	14	18.7	13.5
Aug. ..	1	7	16.1	12.9
Sept. ..	0	0	8.3	9.3
Oct. ...	0	0	9.0	14.2
Nov. ..	3	48	20.3	11.9
Dec. ..	6	23	13.0	13.9
		1904.		
Jan. ...	1	7	14.0	3.4
Feb. ...	0	0	5.5	0.2
Mar. ..	0	0	2.3	1.9
Apl. ...	2	6	11.5	12.0

The rating-table formulae (page 339*) were revised in last September to include all gaugings to date, aggregating 1 599 at Alhajuela, 2,147 at Gamboa and 1,854 at Bohio. The only changes found desirable were to substitute 6 for 8 in the Alhajuela formula, and 24 for 26 in that for Gamboa; but large freshets at Alhajuela had occurred, affording the desired data for a freshet formula at that locality, which is the following.

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* THE ENGINEERING MAGAZINE, December, 1902.

$$Q = -7 + 110\,(C-28) + 40\,(C-28)^2 - 1.8\,(C-28)^3$$

The analysis of the ratio between downfall and drainage, discussed on pages 355 to 362*, has been extended to include all later records, and the results appear in full in the Monthly Weather Review for February, 1904. The conclusion that ground water constitutes a very important part of the volume of the Chagres is amply confirmed. In round numbers it appears that of the entire rainfall in the basin about one-third evaporates, another third flows off directly by the bed of the river, and the residue, after a retardation of perhaps three months by its passage through the soil, ultimately reaches the river as ground water. During the dry months it supplies much the larger part of the flow. In fine, the conditions of this tropical basin as compared with those existing in the northeastern portion of the United States, indicate per square mile about 2.5 times the rainfall, 3.3 times the outflow, and 1.5 times the evaporation.

The matter of the water supply of the canal in the dry season, discussed on pages 362 to 366*, is so important that it has long seemed desirable to make a further and exhaustive analysis of all the available data, with a view to determining as accurately as possible the ratio between the volumes passing Alhajuela, Gamboa, and Bohio in different seasons of the year. Indeed, this has only been deferred in order to accumulate sufficient data, which has now been secured. There are available for comparison 79 measured monthly discharges at Alhajuela, 169 at Gamboa, and 137 at Bohio. The percentages resulting from the analysis, with their probable errors, the latter in this case representing the effect of variations in the location of rainfall at the different dates, may be stated as follows:

The volume passing Alhajuela is 82 ± 2.1 per cent. of that passing Gamboa in the dry season, 76 ± 1.4 per cent. in the rainy season, and 79 ± 1.0 per cent. annually.

The volume passing Alhajuela is 71 ± 2.7 per cent. of that passing Bohio in the dry season, 51 ± 1.5 per cent. in the rainy season, and 55 ± 1.4 per cent. annually.

The volume passing Gamboa is 86 ± 2.0 per cent. of that passing

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* THE ENGINEERING MAGAZINE, December, 1902.

Bohio in the dry season, 65 ± 1.6 per cent. in the rainy season, and 68± 1.4 per cent. annually.

Comparing these percentages with those given on page 362 of the Magazine it will be noted that no important differences appear between them and those heretofore provisionally used, and that the small probable errors justify what has not been attempted before, to wit the supplying of the lacking monthly discharges at Alhajuela by transferring to that station those measured at Gamboa, using the percentage corresponding to the season. The distance between the two localities is only about eleven miles by river. By this process is secured a trustworthy continuous series of monthly discharges at Alhajuela for fifteen consecutive dry seasons and for fourteen consecutive rainy seasons. The figures appear on the following page.

The possession of these figures, representing all that it is desirable to know respecting the monthly flow of the river during more than fourteen years, renders superfluous the tentative analyses contained in the tables on pages 363 and 364 of the Magazine. The mean tri-monthly discharge during February, March and April is shown to be at Alhajuela 965 cubic feet per second, at Gamboa 1,176 cubic feet, and at Bohio 1,371 cubic feet, the corresponding absolute minima being 530, 530, and 753 cubic feet,—the later occurring in the year 1901. So also in regard to the total annual volume which the river can supply, an important consideration when the annual traffic shall approach the maximum that can be mechanically accommodated (about 23,000,000 tons) this table furnishes the desired information. The average volume at Alhajuela is 2,424 cubic feet per second, at Gamboa 3,164 cubic feet, and at Bohio 4,798 cubic feet, the corresponding minima being 1,837 cubic feet, 2,345 cubic feet, and 3,384 cubic feet,—the latter noted at Alhajuela and Gamboa in the year 1900, and at Bohio in 1899. These results, as appears from the discussion in the Magazine do not differ materially from those estimated long ago by the engineers of the New Canal Company.

The river is marvelously adapted to the needs of the Canal, and with a proper system of regulation there will never be a shortage of water or annoying currents in the route traversed by shipping. Now that we have inherited the work it behooves American engineers to recognize that these facts have been established by most thorough and painstaking investigations conducted for many years under difficulties that would have discouraged engineers less able and devoted than Monsieur Maurice Hutin, the director general, and Monsieur Louis Choron, the director of investigations and of construction, and their able assistants on the Isthmus.

MEAN MONTHLY DISCHARGE OF THE CHAGRES IN CUBIC FEET PER SECOND.

Month.	1890	1891	1892	1893	1894	1895	1896	1897	1898	1899	1900	1901	1902	1903	1904	Means.
AT ALHAJUELA.																
Jan.	2190*	**1554**	**1165**	**1731**	**2825**	**2684**	2437	**1342**	**3284**	**2684**	1589	989	4238	1130	3002	2190
Feb.	**1095**	**777**	**918**	**1660**	**1342**	**1236**	1059	**918**	**1236**	**777**	812	671	1271	848	1589	1081
Mar.	**918**	**494**	**812**	**1024**	**777**	742	600	**424**	**600**	**777**	530	459	812	494	954	695
Apl.	**1024**	**424**	**1695**	**2402**	**600**	**918**	1271	**563**	**1519**	883	565	459	1695	565	2190	1118
May	**3249**	**2649**	**4203**	**2331**	**1059**	1483	2543	**2507**	**1872**	1589	1342	1554	2119*	1377	....	2134
June	**4061**	**1801**	**2649**	**2437**	**1695**	2048	2225	**1801**	**2190**	2154	1554	1731	2190	1942	....	2177
July	**4097**	**2861**	**5651**	**2719**	**3390**	1801	**2225**	**2861**	**3143**	2225	2190	1978	2119	3108	....	2883
Aug.	**4309**	**2119**	**4626**	**3602**	**2967**	2543	2145	**3108**	**3143**	3284	2825	2437	2331	3178	....	3044
Sept.	**5191**	**2296**	**3320**	**2967**	**3390**	1907	2154	**2931**	**1907**	2402	2154	2931	2366	2790	....	2765
Oct.	**4909**	**3390**	**4521**	**2896**	**3567**	3638	2048	**2931**	**2649**	2649	3214	2755	3214	2755	....	3224
Nov.	**3002**	**5686**	**5509**	**3461**	**4980**	2543	2472	**3390**	**3885**	2931	2967	4768	3143	4909	....	3832
Dec.	**4485**	**3885**	**4627**	**6110**	**8088**	3920	**3885**	**3532**	**1731**	2260	2296	3037	1836	5474	....	3940
Year	3211	2328	3308	2778	2890	2122	2089	2192	2263	2051	1837	1981	2278	2381	....	2424
3 dry	1012	565	1142	1695	906	965	977	635	1118	812	636	530	1259	636	1578	965
Rainy	3944	2917	4030	3139	3551	2507	2459	2711	2645	2464	2237	2453	2617	2963	....	2910
AT GAMBOA.																
Jan.	2755*	2048	1519	2296	3708	3532	2225	1766	4309	3496	1695	1024	5227	1625	4132	2757
Feb.	1342	954	1095	2013	1625	1483	1130	1130	1483	954	812	671	1589	918	2402	1307
Mar.	1045	600	989	1236	954	1095	636	494	1024	954	530	459	1024	706	1695	896
Apl.	1059	530	2048	2931	742	1130	1342	671	1836	1059	565	459	1942	706	2861	1325
May	4273	3461	5509	3037	1377	3461	4450	3284	2472	1907	1342	1766	2896*	1519	....	2904
June	5333	2366	3496	3214	2225	3178	4132	2366	2861	2472	1942	2048	2896	2154	....	2906
July	5403	3779	7416	3567	4450	3073	2931	3779	4238	2825	3355	2190	3002	3320	....	3809
Aug.	5686	2790	6075	4732	3885	4061	2331	4097	4132	4238	3567	2861	2790	4344	....	3971
Sept.	6816	3037	4379	3885	4450	3390	2719	3850	2543	3178	3073	3638	2931	4697	....	3756
Oct.	6498	4450	5933	3744	4697	4944	2684	3850	3461	3390	4520	3702	4415	3956	....	4303
Nov.	3956	7487	7240	4556	6534	3532	**3249**	4450	5192	3744	4061	6746	4732	5721	....	5086
Dec.	5898	5121	6075	8052	10630	3779	5121	4626	2296	2649	2684	3143	2190	7028	....	4949
Year	4172	3052	4314	3605	3773	3055	2750	2864	2987	2572	2345	2391	2969	3058	....	3164
3 dry	1149	695	1377	2060	1107	1236	1036	765	1448	989	636	530	1518	777	2319	1176
Rainy	5180	3838	5294	4120	4662	3661	3317	3563	3500	3100	2915	3013	3453	3818	....	3827
AT BOHIO.																
Jan.	4132*	2684	**2331**	**3532**	7063	4556	4732	2048	5651	3850	2119	1483	11231	1625	4944	4132
Feb.	**1554**	1377	**1271**	**2331**	1801	1377	1554	1589	1695	1731	1059	989	2084	1024	2331	1585
Mar.	**1271**	600	**1165**	**1448**	1095	1059	1695	706	1095	989	742	706	1271	636	1413	1009
Apl.	**1236**	600	**2366**	**3426**	777	1059	1695	883	2013	1095	706	565	2154	565	3638	1519
May	**6569**	5333	**8476**	**4662**	3355	4167	4944	7982	2684	2048	1625	2296	4273*	1519	....	4281
June	**8193**	3214	**5439**	4944	4273	4309	4203	4203	3355	3143	2861	2790	3178	2543	....	4046
July	**8300**	4803	**11407**	7628	6216	4591	3143	5121	6569	3956	5615	3178	3037	4026	....	5542
Aug.	**8759**	4521	**9359**	10772	6498	6922	3496	7275	5298	5721	5262	4309	3390	5474	....	6218
Sept.	**10489**	**4344**	**6746**	7664	7452	5792	5933	6887	3214	4238	4768	5792	3920	5686	....	5923
Oct.	**9995**	**6851**	**9112**	8582	9359	6922	6357	7487	5050	4944	6993	6322	5933	5580	....	7106
Nov.	**6075**	**11513**	**11125**	11443	12714	6075	7593	6957	7840	5296	6605	13244	6675	8335	....	8678
Dec.	**9076**	**7876**	**9359**	18541	12573	6957	6039	6816	2861	3602	3744	4591	3002	10489	....	7538
Year	6304	4476	6513	7081	6098	4482	4216	4830	3944	3384	3509	3855	4179	3958	....	4798
3 dry	1354	859	1601	2402	1224	1165	1377	1059	1601	1272	836	753	1836	742	2461	1371
Rainy	7954	5682	8150	8641	7723	5588	5160	6086	4725	4089	4400	4889	4960	5031	....	5940

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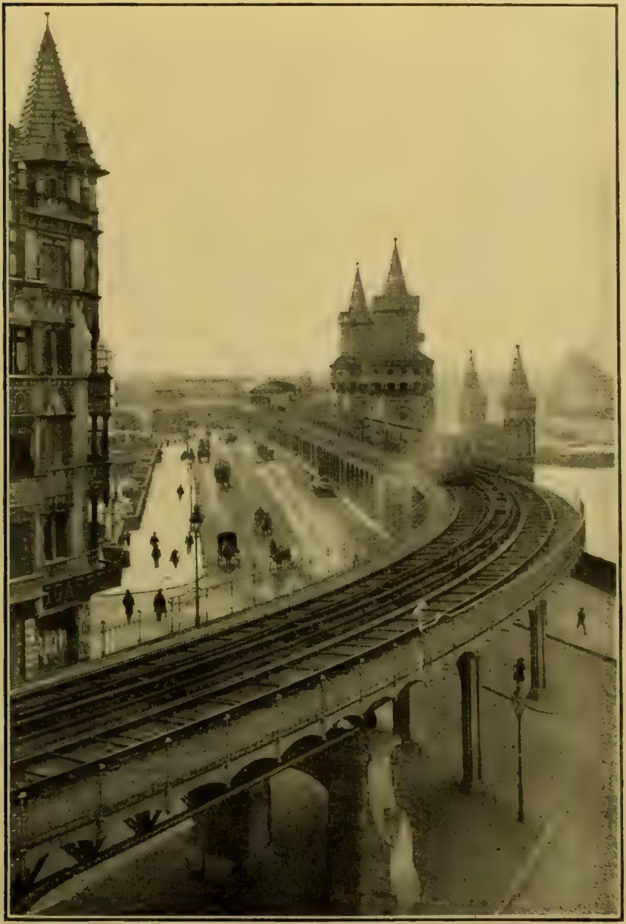
* Interpolation, means of all months of same name at station.

This table replaces Table II of the Appendix, page 368, THE ENGINEERING MAGAZINE for December, 1902. Figures marked by heavier faced type are transferred from adjacent station by the use of the percentages given on pages 728 and 729.

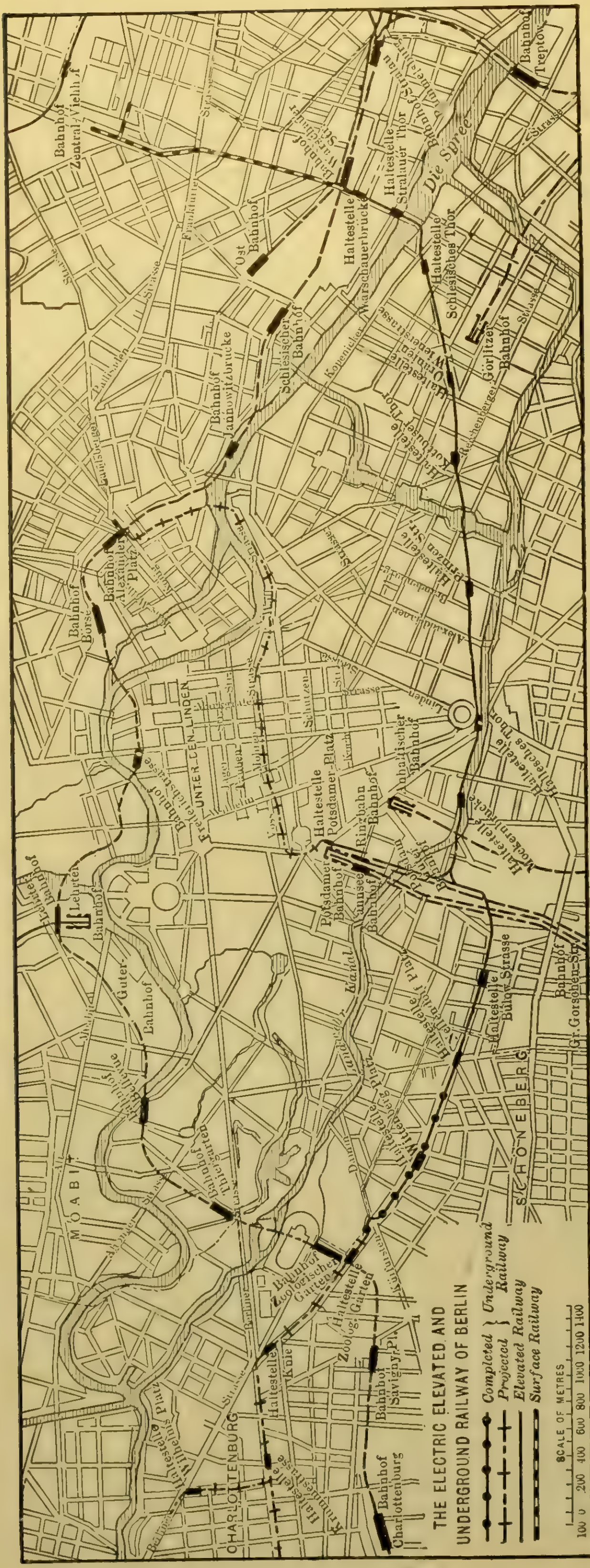
THE BERLIN COMBINED ELEVATED AND UNDERGROUND RAILWAY.

By Paul Möller.

The following article is the second of a series of three, presented as especially pertinent to the approaching opening of one of the most important rapid-transit lines in the world—the New York underground. The first of the series was published in this magazine in June last, and described the latest of the London tubes. The third, which will follow in a later number, will describe the New York underground itself.—The Editors.



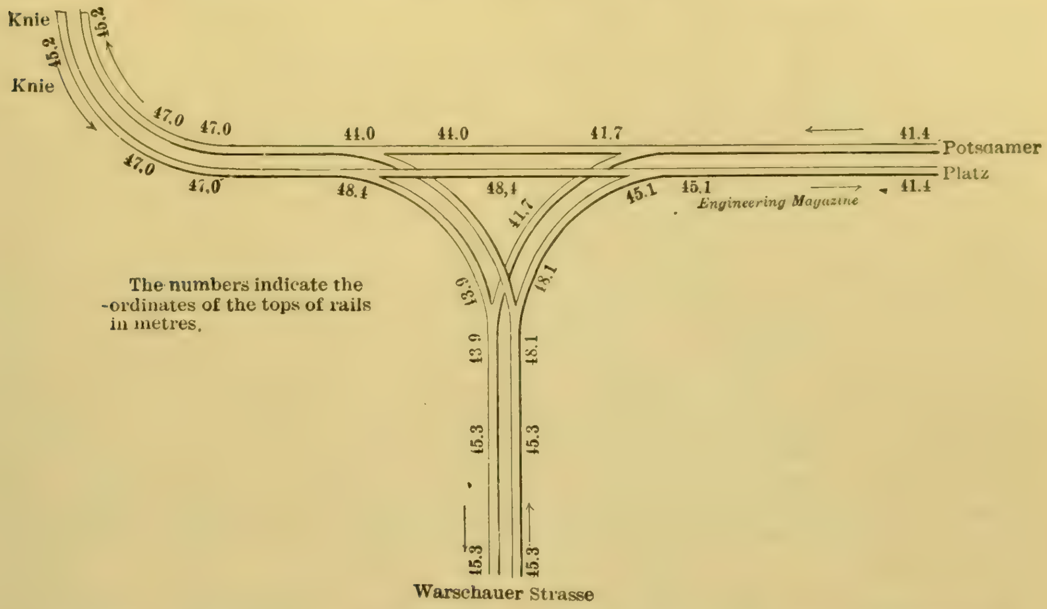
THE map of greater Berlin shows a larger extension from east to west than in other directions, the expansion following the course of the Spree river, and necessarily the main stream of traffic moves on the same line. Besides the tramways, which for several years have all been operated by electric power, the Metropolitan Railway (Stadtbahn), built 22 years ago on masonry arches and still using steam locomotives, was at the disposition of the public. The Metropolitan connects Rummelsburg, a suburb in the east, and the city of Charlottenburg, the neighbouring city in the west of the capital, both being practically parts of greater Berlin. The line is not straight from east to west, making a curve to the north; consequently the southern quarters were for a long period without a rapid-transit connection, and the new Combined Elevated and Underground Railway was designed to supply this want. (See the map on the next page.)



OUTLINE RAILWAY MAP OF BERLIN. THE SIMPLE BROKEN LINES SHOW THE STADTBAHN AND OTHER STEAM RAILWAYS.

The new road, like the Metropolitan, connects the east end of Berlin, the "Warschauer Strasse," with the "Knie" of Charlottenburg, but it traverses the southern part of the city. Besides the main line it has a short branch going to the "Potsdamer Platz." At the eastern terminus an electric surface tramway running to the Berlin stockyards (Zentral Viehhof) forms a prolongation of the railway.

The Electric Elevated and Underground Railway was built by the Siemens & Halske Co. for a company especially founded for that purpose under the name of "Gesellschaft für Elektrische Hoch-und Untergrundbahnen." After having obtained the authorisation by royal approval and by contracts with the municipalities of the different cities touched by the line, the Siemens & Halske Co. began the work in the autumn of 1896, and the railroad, having then a length of 10.5 kilometres, was finished in 5½ years. The cost of construction, including purchase of land and buildings, was about 30,000,000 marks, so that the cost of one kilometre of the line was on the average about 3,000,000 marks, while the Paris Metropolitan cost 3,500,000 and the London Central Railway 7,500,000 marks per kilometre.



The numbers indicate the -ordinates of the tops of rails in metres.

Engineering Magazine

DIAGRAM OF TRIANGULAR INTERSECTION, BERLIN ELEVATED AND UNDERGROUND RAILWAY.

From the Zeitschrift des Vereines Deutscher Ingenieure.

The standard gauge was adopted in order to make it possible to haul regular railway cars if desired, and the line is double tracked throughout. It runs, as the name implies, partly overhead and partly underground. On the eastern division, where most of the streets touched by the line have a central promenade and a width of 31 to 52 metres, a steel structure could be easily built; one section utilises a small strip of 7 metres between the public street and a ship canal. But where the branch line of the new railroad ends, near the Potsdamer Platz, the space was too small for a steel structure, and in some streets of the western division—the quarter of the rich—though broad enough, the landlords and the parish of the magnificent "Kaiser Wilhelm Gedächtnis" church strongly opposed the construction of an elevated road, claiming that the appearance of the city would be spoiled. So it became a necessity to conduct the line here underground and to join these parts with the elevated division by inclines, of which the sharpest has a grade of 1 in 32, as it was thought that no other means of lifting and lowering the trains would be fast and safe enough for a rapid transit. However it is worth noting that the inclines have never caused the least trouble. The scheme of inclines adopted, it was necessary to build the tunnel as near as possible below the street level in order to have only a small difference of height between the elevated and the underground lines. Another and not less important reason for this location of the tunnel was that the soil of Berlin consists mostly of quick-sand and the ground-water level is very high.

The most interesting construction of the road is the so-called "Gleisdreieck," a triangular junction between the main line and the above-mentioned branch leading to the Potsdamer Platz. The idea was to join the three different arms without any crossing of tracks on the same level, which would be too dangerous for a rapid-transit road. The problem was solved in this way, that one of the tracks intersecting another rises to such a height that it can be conducted over the lower track on an independent level. To get the required difference of levels grades of 1 in 38 were necessary. The sketch on the preceding page shows the crossings.

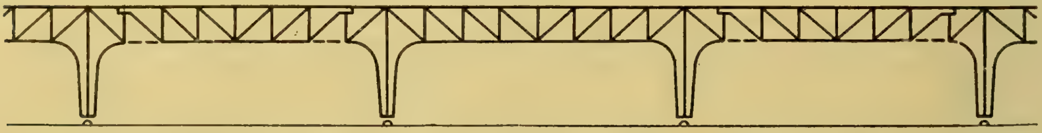
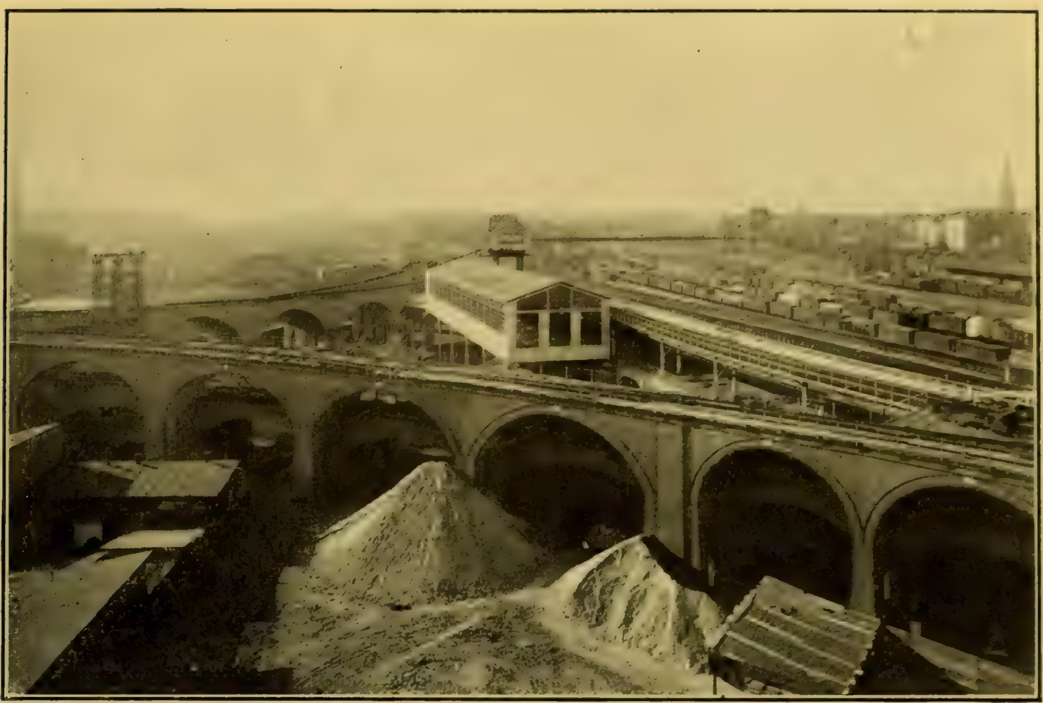


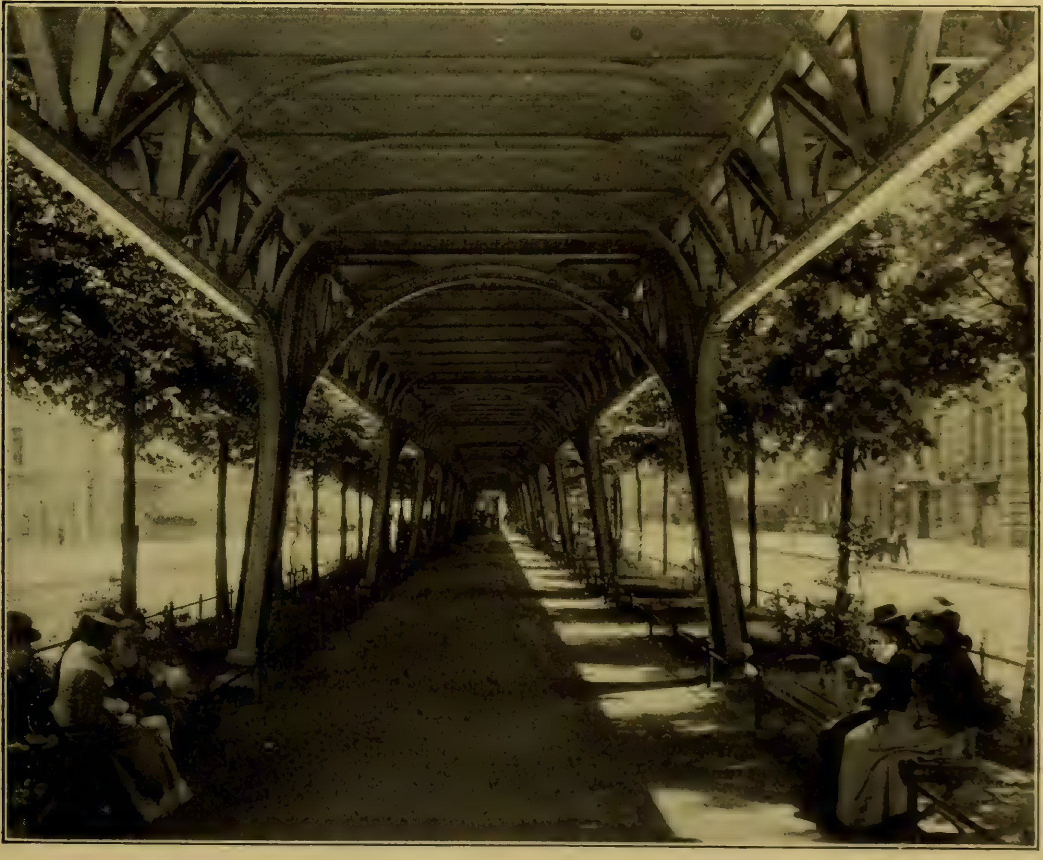
DIAGRAM OF SUPERSTRUCTURE CONSTRUCTION, BERLIN ELEVATED RAILWAY.

As the triangular junction is built within the boundary of the State railway and is removed from the city streets, the structure could be of masonry. But nearly all other viaducts, i. e., about 7,300 metres of the whole line, are constructed of steel. Various types of girders and pillars are used, but the most interesting seems to be a kind of cantilever construction consisting of a portal superstructure with projecting arms of which the extreme points are connected by a girder. The principle in designing the steel viaducts was that the street area obstructed by pillars or foundations should be a minimum. Besides, it was argued that the appearance should be attractive from an aesthetic standpoint, and the Siemens & Halske Co. charged some well-known architects with this task. In fact, the greater part of the structure in this respect is so great a success that the United States Consul General, Mr. Frank H. Mason, said in one of his consular reports: "The one respect in which the German constructors leave their American colleagues far behind, and offer an object lesson which our countrymen cannot study too soon or too thoroughly, is in the artistic beauty, the architectural charm and sense of fitness, which they have imparted to the stations, the bridges and even to the ordinary overhead viaduct sections of the new road."

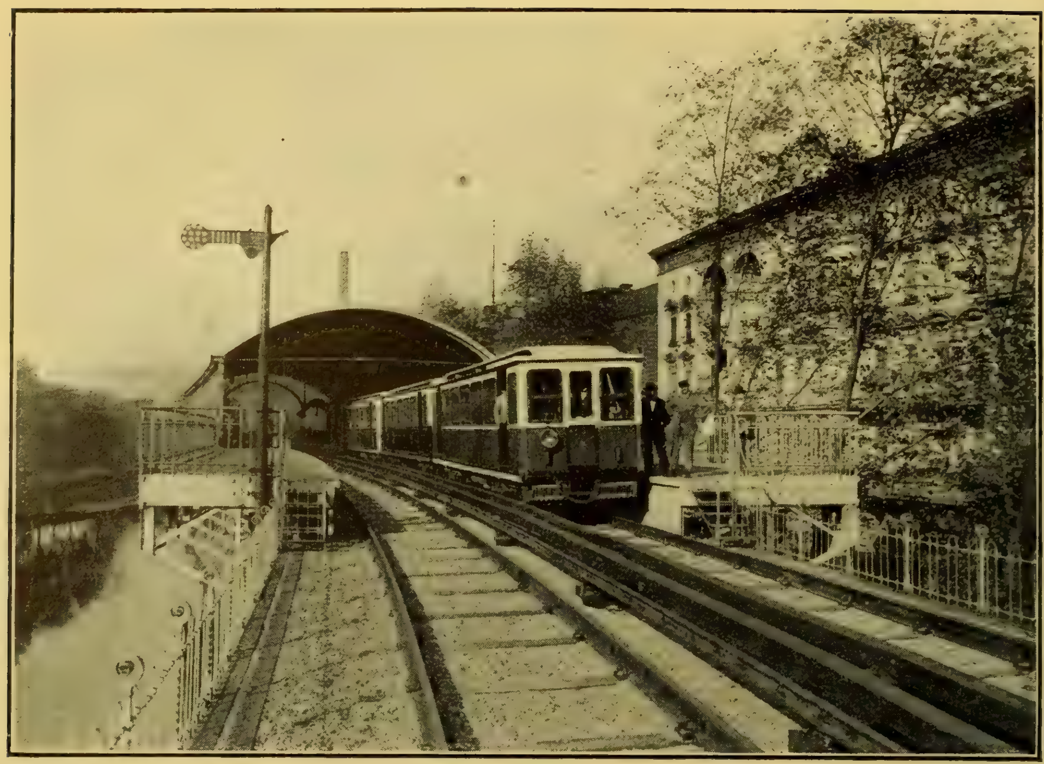
Another problem was not so thoroughly solved, i. e., the suppression of the noise caused by passing trains. On the eastern division the



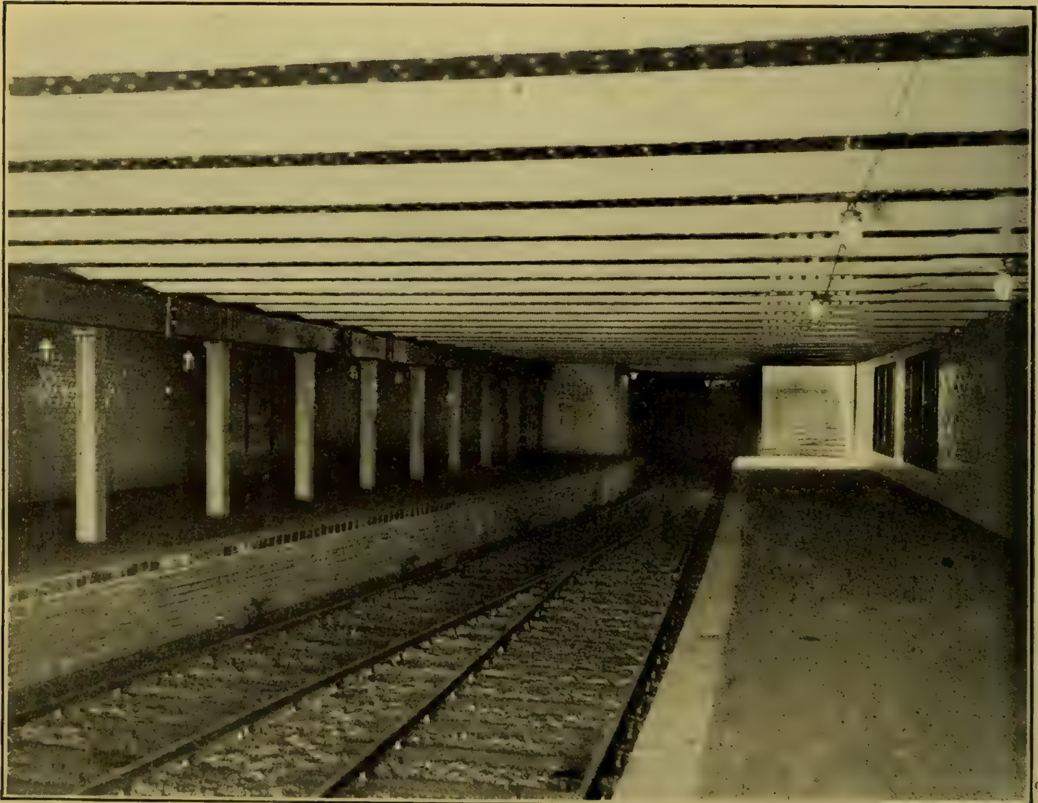
THE TRIANGULAR INTERSECTION.



UNDERNEATH THE VIADUCT, ON BÜLOW STRASSE.



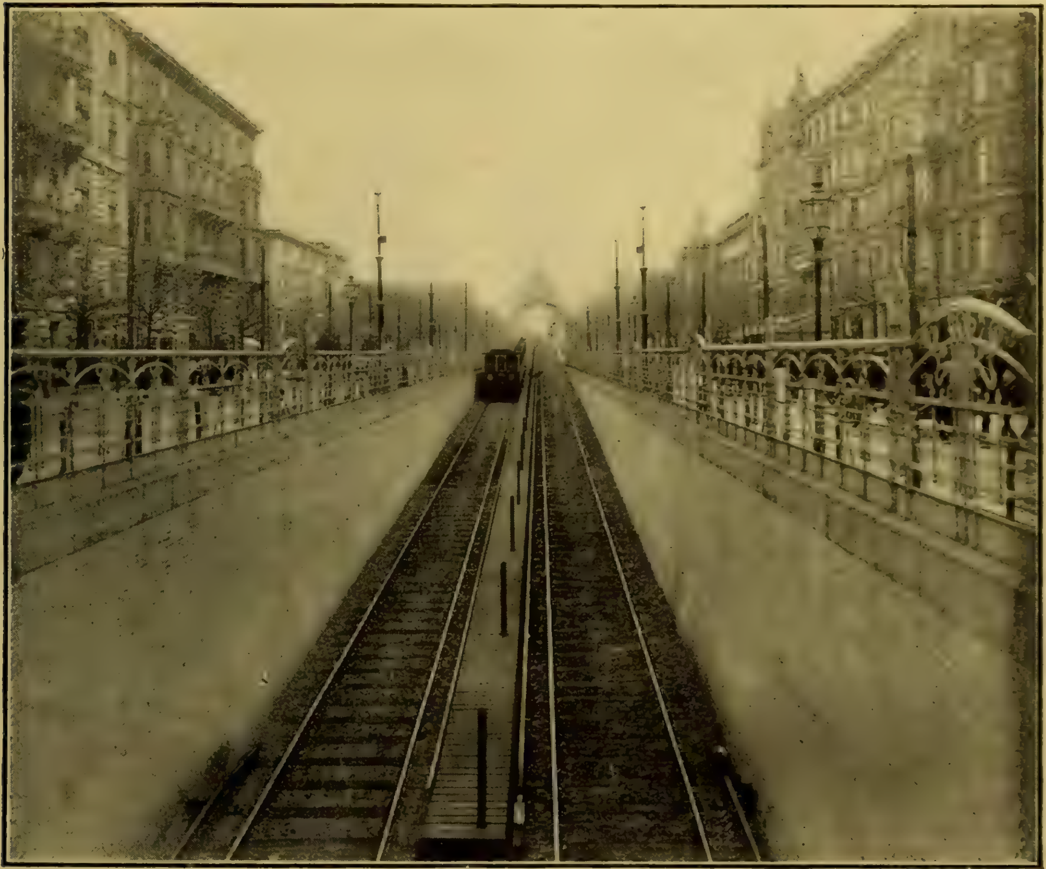
A TYPICAL STATION ON THE OVERHEAD PORTION OF THE LINE.



STATION PLATFORMS ON THE UNDERGROUND PORTION OF THE LINE.

troughs of sheet-iron forming connection of the cross girders are filled with concrete and gravel, while the cross sleepers are fixed directly on the girders. On the western part of the sleepers are bedded in gravel, and the latter type damps the noise far the better.

In constructing the tunnel it was a necessity to restrict the dimensions so far as possible, the reasons being the same as for building it close under the street level. Therefore the cross section is 6.24 metres wide and 3.3 metres high, measured from top of rails. At the stations the width is augmented to 12.64 metres, so that on each side of the tracks a platform 3.5 metres wide might be disposed—a proportion which seems somewhat small if traffic is great. The bottom and the side walls of the tunnel are built of rammed concrete. The ceiling is supported by the walls and by iron columns standing in the middle between the two tracks, and consists of concrete arches spanned between I-beams. The path for the supervision of the line is between the two tracks, where the guards may find a hold at the columns, while on the elevated part two paths are built outside the tracks. The whole body of the tunnel is covered by a layer of asphalt-board (*asphaltpappe*) preventing both ground and surface water



THE APPROACH TO THE UNDERGROUND SECTION, SHOWING THE CHANGE IN POSITION OF THIRD RAIL.

from entering. Besides this a small gutter is left in the middle of each track in the bottom. The tunnel was built in open cuts, and the ground-water level was lowered during construction by pumping.

For the permanent way two different types of rail are used; on the eastern division, where the sleepers are set on the cross girders of the steel structure, it was necessary to choose a strong profile because of the spacing of the cross girders being 1.5 metres apart. Therefore the rails are 180 millimetres high and weigh 42.7 kilos per metre. On the rest of the line, where the sleepers, embedded in gravel, are only 0.71 metres distant from each other, the constructors restricted themselves to a rail of 115 millimetres height and 25.6 kilos per metre weight. The rails are not set under an angle of 1 to 20, as usual, but in a vertical position, as by the use of electric motors and bogie trucks the oscillating movements of the cars are small, and hence the tendency of the rails to tilt is greatly diminished. For the same reason the tyres have a cylindrical rim. In fact, the movement of the cars is very smooth, though the rails are not extremely strong, and that even in curves of which the sharpest has a radius of 80 metres.

OBERBAUMBRÜCKE AND THE STRALAUER GATE STATION OF THE BERLIN ELEVATED AND UNDERGROUND RAILWAY.

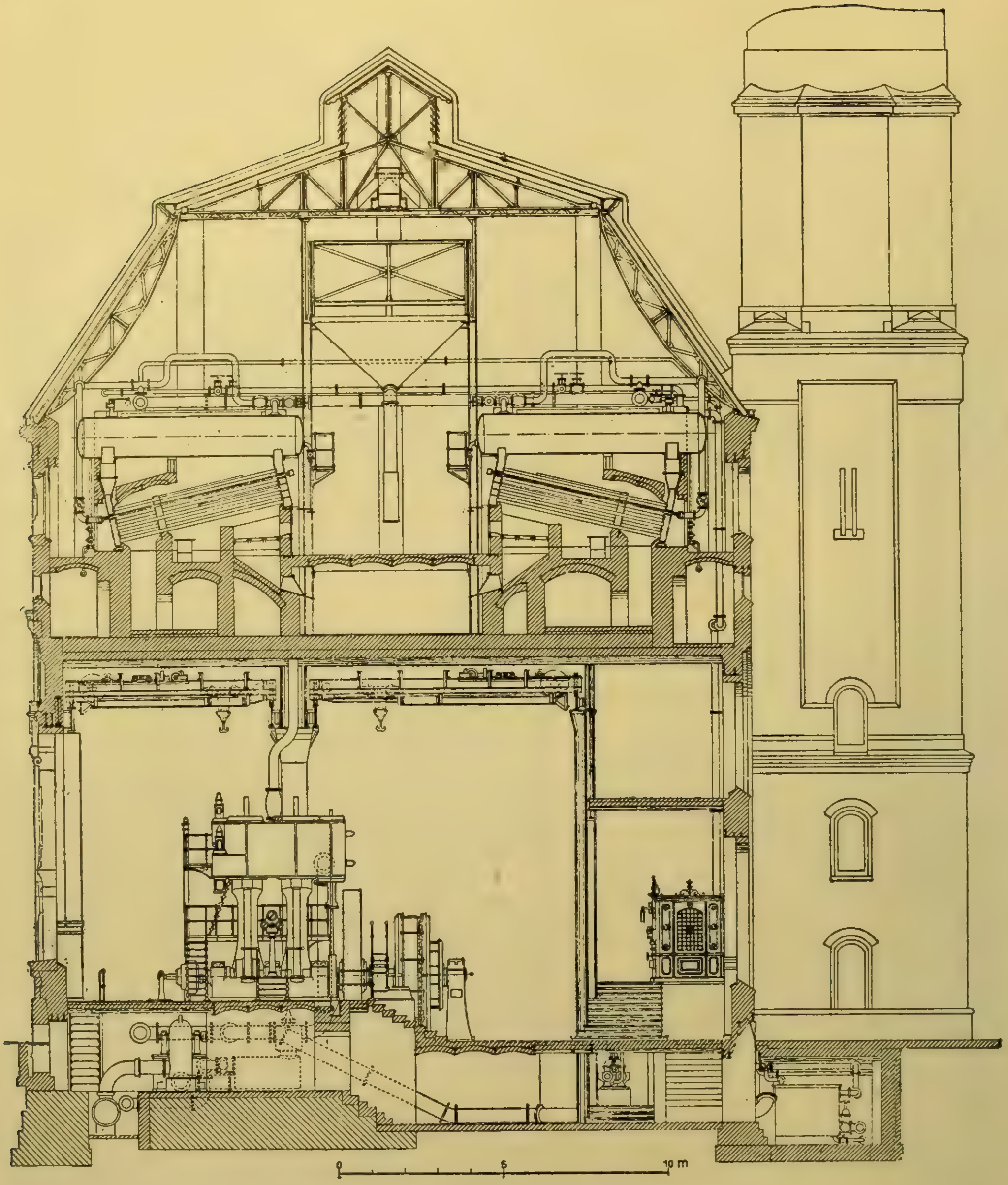
The motive power is supplied by continuous current of 750 volts at the generators and is distributed over the line by means of flat copper bars supported by porcelain insulators. For feeding the motors the third-rail system has been adopted, common rails on vulcanite insulators being used. On the elevated line the contact rails are laid be-

THE RAILWAY OCCUPYING THE STRIP BETWEEN ROADWAY AND RIVER.

tween the two tracks and are protected by wooden guards; on the underground line they are disposed outside the tracks near the side walls, and are usually unprotected. This difference of construction will be explained by the fact that on the former line the foot-path is outside, on the latter inside, the two tracks. For lighting the stations and the tunnel special copper wires are disposed.

The power station is situated near the Spree River and close to the triangular junction, the centre of the need of power. The building, several stories high, contains in the cellar the condensers and pumps, in the first story the steam-engines and generators, above that the chimney-flues and the channels for removal of ashes, and in the upper

THE STATION AT SCHLEISCHES GATE.



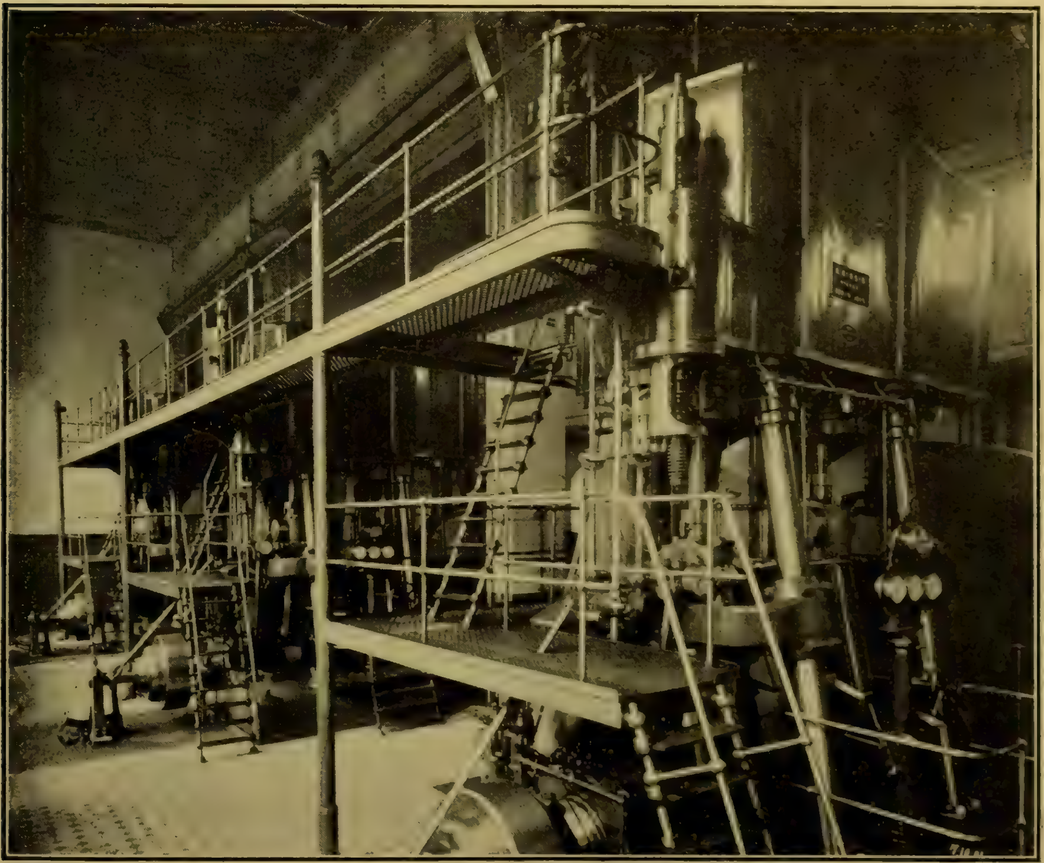
ELEVATION OF POWER HOUSE, BERLIN ELEVATED AND UNDERGROUND RAILWAY.

story the boilers. The coal is carried from the yard to the bins under the roof by a conveyor, and is supplied to the furnaces from a platform between the two rows of boilers. At the present time another conveyor is in course of construction, bringing the coal from shipboard through a tunnel underneath the public street to the yard.

There are six water-tube boilers of the Gehre type constructed for a pressure of 10 atmospheres and furnished with superheaters allowing a steam temperature of 225 degrees Celsius. The engines are of the upright compound type, and at present there are set three engines of 900 to 1,200 horse power and two of 1,200 to 1,500 horse power. They are directly coupled with Siemens & Halske shunt-wound generators of 750 volts. A storage battery of 1,000 ampere-hours capacity is used for equalising sudden changes of current.

The trains are composed generally of three cars, but during the hours of greater traffic of four. Besides this, in summer time two-car trains are run sometimes. The car-bodies are 12 metres long and 2.36 metres wide, and are supported by two 2-axle bogie trucks, each being able to carry two motors, but at present there are only three for each car, of 60 horse power normal capacity each, which are sufficient for the length of trains now used. During the ordinary run the motors are connected in series, while in starting they work in parallel, so that the acceleration is equal to 0.7 metres per second, this high figure being necessary on account of the short distance between stations. As a rule the first and the last car of a train are furnished with motors, and the maximum speed attained is 50 kilometres per hour. The cars have air brakes, the air pump and the air tank being underneath the car body between the trucks. The pump is driven by a small electric motor set in the driver's box. In case of danger a short-circuit brake or a hand brake may be used.

The cars have two side doors, one near each end, and on enter-

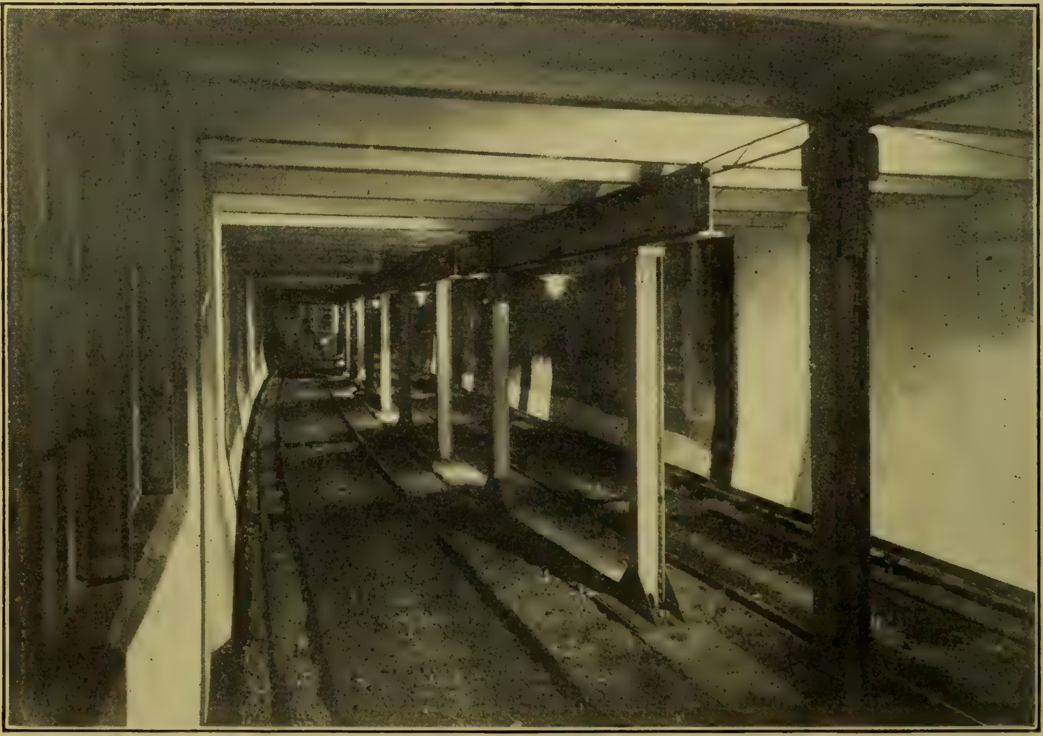


THE INTERIOR OF THE ENGINE ROOM IN THE POWER STATION.

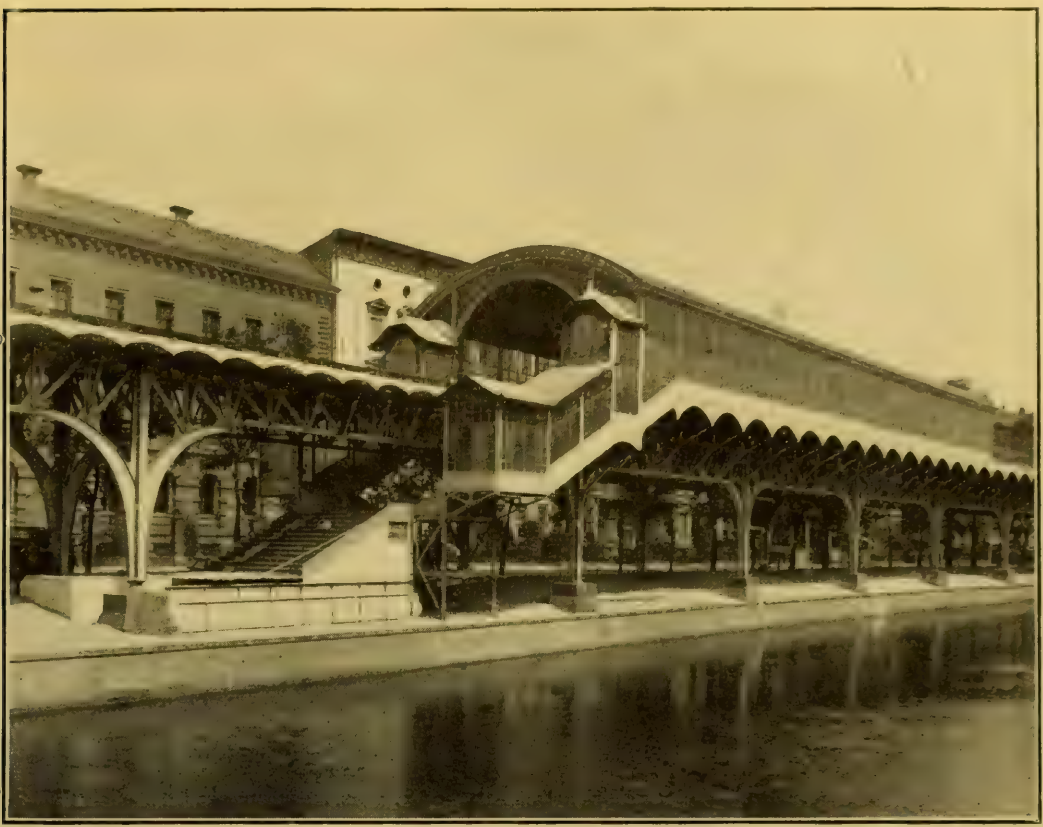
ing the passengers pass through a vestibule open to the main room, where seats are arranged lengthwise and facing each other. On each side are fifteen seats of 51-centimetres width. More seats are in the vestibule, so that 35 to 40 passengers can be seated, but during the rush hours many persons are forced to stand, though the crowd is not so terrible as during certain hours on the New York elevated. The cars are lighted by twelve incandescent lamps, and are nicely furnished and very clean. An inconvenience is felt in summer time in that the windows cannot be opened on account of the narrow section of the tunnel. The result is that the air is sometimes insupportable, as the small openings underneath the roof are insufficient for ventilation; during winter the cars are well heated by electricity. The ordinary trains are composed of two third-class cars, one being a smoker, and between these two is one second-class car, divided by a door into two compartments, smoking and non-smoking. The third-class has wooden, the second upholstered seats.

For the safety of the railway a block-signalling system of the Siemens & Halske type has been established, and all stations, the power house, and the offices are connected by telephone.

The distance between the stations varies from 322 to 1,923 metres, and is on the average about 900 metres. The time consumed for running the trains over the three different lines is as follows:



A VIEW ALONG THE UNDERGROUND PART OF THE LINE, SHOWING THE OUTSIDE POWER-RAILS AND CENTER PATH.



THE STATION AT MÖCKERN BRÜCKE.

Line.	*Distance in Metres.*	*Time in Minutes.*
Warschauer Brücke—Möckern Brücke—Bülow Strasse—Knie	9,690	23
Warschauer Brücke — Möckern Brücke — Potsdamer Platz	6,330	15
Potsdamer Platz—Bülow Strasse—Knie	5,250	12

The platforms at the stations are separate for the two directions of travel, each platform having its own staircase. The level of the platforms is 0.8 metres above the top of rails, so that the passengers can enter the cars without any step.

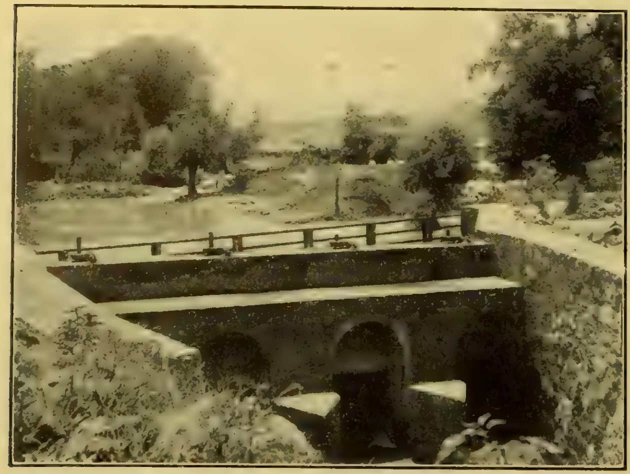
The trains run on a headway of 2½ to 5 minutes, the average being 3.9 minutes. The present number of third-class cars is 73, of second-class cars 31. The fares are cheap—for a trip to the fourth station, in the third class, 10 pfennige (2½ cents) ; in the second class, 15 pfennige. To the seventh station; third class, 15 pfennige; second class, 20 pfennige; beyond that, 20 and 30 pfennige.

The new railway has become in a very short time an important factor in the public life of the German capital, and there can be no doubt that the projected new branches will be a success also. The most important project is the junction of the Potsdamer Platz with the Alexander Platz by a line which will cut through the heart of Berlin. All the new lines will be built as underground railways.

A NOTABLE MEXICAN HYDRO-ELECTRIC PLANT.

By Robert McF. Doble.

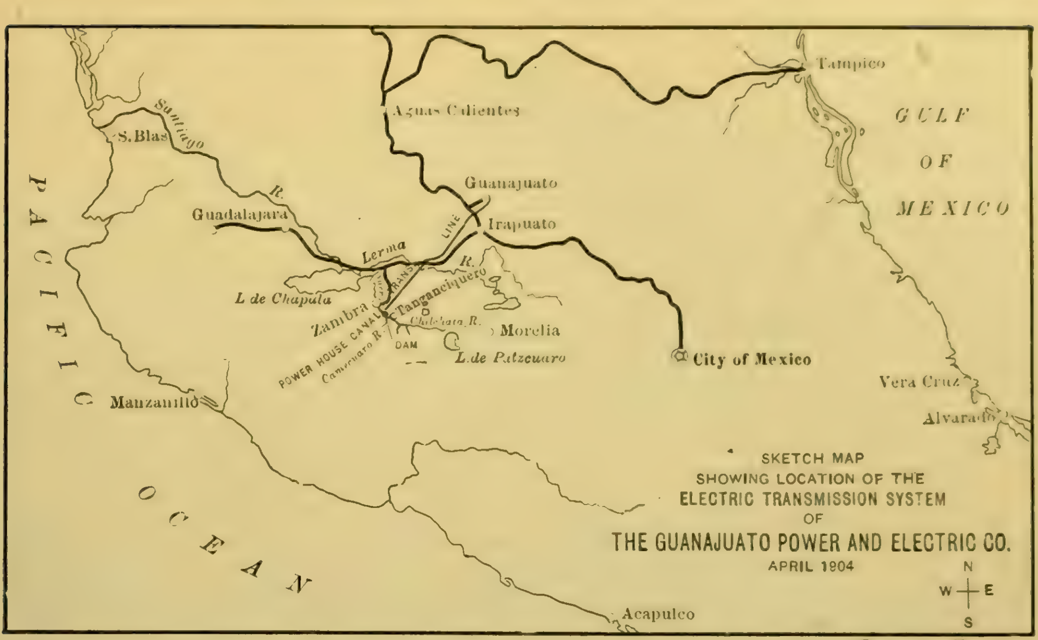
Mr. Doble's article is presented as a typical example of the opportunities which modern engineering developments afford for the exercise of professional talent, the use of machinery and appliances, and by their joint application, for the fuller and more profitable utilization of the natural resources of the earth.—The Editors.



THE HEADWORKS OF THE GUANAJUATO POWER CANAL.

A VERY important addition to the rapidly increasing list of hydro-electric power developments and high-potential long-distance transmissions, has recently been completed in the States of Michoacan and Guanajuato, Republic of Mexico, at the location shown on the accompanying sketch map. Under a concession from the Department of Encouragement, Colonization, and Industry of the Republic of Mexico, The Guanajuato Power and Electric Company constructed a canal, pipe line, power-generating station, transmission line, substations, and distributing systems for developing and marketing the motive power of 8,000 litres (283 cubic feet) of water per second of the Duero River.

The water supply is derived principally from the numerous springs which issue from the porous volcanic rock at many points in the extensive watershed area. That the underground storage is large and reliable is demonstrated by the slightness of the variations in the volume discharged by the springs. The region drained by the Chilchota River is a series of fertile valleys, lying one above the other, having a total area estimated at 400 square miles and extending to the Continental Divide. It embraces many high mountains, some of which are timbered, and some lakes with no visible outlets. The elevation is from 5,000 to more than 12,000 feet above sea level. The Camecuaro River is fed entirely by the Camecuaro Springs. It is only about one



Engineering Magazine

SKETCH MAP OF THE GUANAJUATO POWER TRANSMISSION.

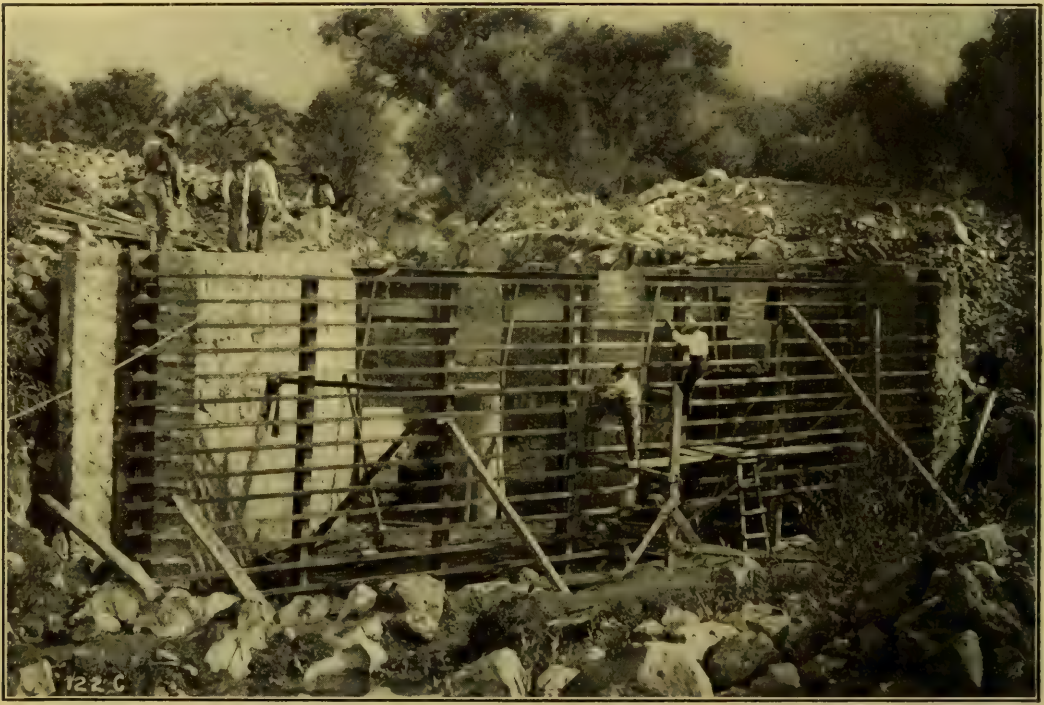
mile long and has practically no drainage area. The Duero River is formed by the Chilchota and Camecuaro Rivers, at the confluence of which the diverting dam and head works of the canal have been constructed.

The masonry dam is built of volcanic rock, the interior being laid up with lime mortar and the exterior with Portland cement. It is a curved structure with a radius of 88.19 metres, the length of the crest being 80 metres. Its elevation is 1,662.40 metres above sea level. It is computed as a gravity dam for a maximum depth of 1.60 metres of water over the crest.

A heavy steel fender (page 746) securely braced against the masonry, protects the entrance to the canal from the drift brought down by the freshets during the rainy season. Water is admitted to the canal through four head gates (page 744) each with an opening 1.25 by 2.00 metres, at a maximum velocity of about 0.80 metres per second. These head gates run in an angle-iron frame set in the concrete, are made of wood heavily ironed, and are operated by means of a screw stem and a worm gear nut with ball bearings, which is turned by means of a hand crank operating a worm spindle with bronze thrust collars.

The canal is 6,650 metres long, of trapezoidal section, 4 metres wide on the bottom and 2.10 metres deep. The side slopes are 1 to 1 in soft earth, 0.5 to 1 in hard rock and 0.2 to 1 where the canal is lined with cement. Its slope is uniform 1 to 2,500. Its carrying capacity is 283 cubic feet per second at a velocity of between two and three feet per second.

To provide for accurately measuring the volume of water allowed under the concession, a "rating flume" was constructed near the head works. It is about 100 feet of straight canal lined with Portland cement held in place by sheets of expanded metal. The top of the wall on the side toward the river is finished with an adjustable metal weir (see the opposite page) set so as to act as spillway when more than the proper volume of water is flowing. A short distance down stream the canal is widened and deepened, causing a reduction in the velocity of the flowing water to about one-third of the normal so that any sand may settle to the bottom. This settling basin (page 747) is provided with six valves, opening from its bottom into a culvert which leads out from under the canal to the river. These valves are of new and interesting design, consisting of a circular cast-iron opening 18 inches in diameter closed by means of a conical cast-iron bell, drawn point up into the opening from below and held there by means of a threaded stem and nut which rests upon two channel beams spanning the canal. By turning the nut the cast-iron bell may be lowered to open the valve and wash out the sand which has collected at the bottom. Immediately below the settling basin there is an adjustable submerged weir, shown quite plainly on the facing page. By means of



THE HEAVY STEEL FENDER AT THE HEADWORKS.

THE RATING FLUME, SHOWING THE ADJUSTABLE STEEL LIP.

the head gates and by the adjustable lip at the rating flume in conjunction with the submerged weir, the quantity of water flowing in the canal may be closely regulated.

From this point the greater portion of the canal is of the character shown on the next page. It meanders along the southerly side of the canyon, under a substantial masonry-arch road bridge 33 feet wide and 16 feet span, over a massive masonry aqueduct to a spillway, and thence to a second sand trap near the forebay. The spillway and second sand trap are located so as to make use of the Barranca de La Rojena as a waste-water way leading to the Duero River. A small storage reservoir is constructed alongside the canal at the forebay, having a capacity of more than 2,000 litres per second for four hours. At the entrance to the forebay the water passes over a measuring weir. On passing from the forebay

THE UPPER SAND TRAP AND THE ADJUSTABLE SUBMERGED WEIR.

THE WINDING CANAL.

to the penstock the water flows through a screen which removes all floating debris. (See page 750.)

The massive masonry penstock is strengthened by embedded iron hoops and is interesting because of its excellent hydraulic lines. The water, after passing through the screens and through four gates similar to those at the head works, enters two ellipsoidal masonry basins which gradually diminish in diameter toward the bottom, merging into the great oval taper sections which are the heads of the pipe lines (Page 751). This design causes a gradual acceleration in the velocity of the water and also prevents the formation of the whirling vortex which would draw in air.

The pipe line is 3,300 feet long, with no lateral bends. It varies in diameter and thickness as shown in the following table, and was designed with a safety factor of five.

Inside Diameter of Pipe.	Thickness of Plate.	Approximate Length.
69 inches	5/16 inches	1,100 feet
63 "	3/8 "	1,000 "
63 "	7/16 "	100 "
57 "	7/16 "	350 "
57 "	1/2 "	350 "
57 "	9/16 "	200 "
57 "	5/8 "	200 "
Total		3,300 "

The decrease in the diameters of the pipe section causes an acceleration in the flow of the water as it descends. This also made possible the nesting of sections for shipment. The pipe was made up from steel plates, in sections 27½ feet long and weighing from 7,000 to 10,000 pounds each.

All seams were lapped and the longitudinal seams were designed so as to have at least 70 per cent. of the strength of the plate. These longitudinal seams were placed so that they are on top of the pipe and alternately opposite, with the calking edges up as shown on page 752. The longitudinal seams are double-riveted, the circular seams single-riveted. All the shop riveting was done by a large hydraulic riveter. The field riveting was done by hand by a gang of expert boiler makers sent to Mexico for that purpose. Two riveters, a helper, and a man at the forge to heat rivets could finish one circular seam in a day. When riveted the pipe was calked and an extra coat of preservative paint was applied. Each section of the pipe had on top, near its lower end, a hole through which the hot rivets were passed from the forge to the man inside. The hole was tapped and a plug screwed in after the joint was riveted (see page 752). Each section was plainly marked at the factory with letters indicating its position in the pipe line.

The common practice of laying pipes of this character on top of

THE MASSIVE MASONRY AQUEDUCT CARRYING THE POWER CANAL.

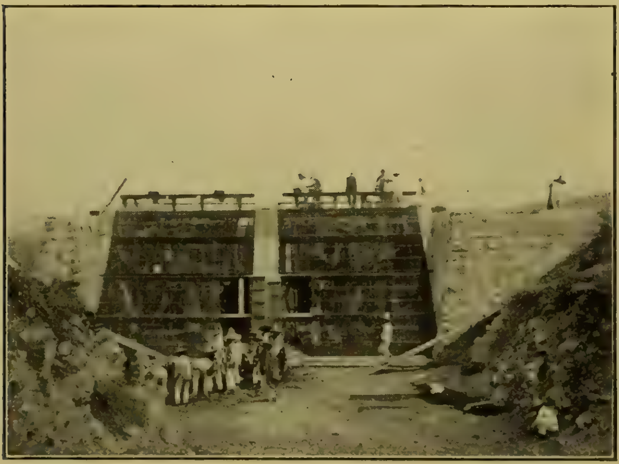
THE FOREBAY AND PENSTOCK.

the ground and supporting them on piers was not followed. A trench was dug, the bottom of which was graded on long tangents and with slight vertical angles. The pipe was laid in this trench, beginning with the section nearest the power house and riveting on section after section, working up hill. Bell holes were dug in the bottom of the trench so that the riveters might have room to swing their hammers. The back filling of the trench was done with great care, the earth being dampened and thoroughly tamped under and around the pipe. During the early morning hours, while the pipe was cool and at its minimum length, the top covering was completed.

On August 24th, 1903, the pipe was tested, and so well had the work been done that not a single leak was found, although there are over 70,000 rivets.

The pressure pipe terminates at the bottom of the hill in a branching cast-iron pipe leading through the south wall of the power house to the nozzles.

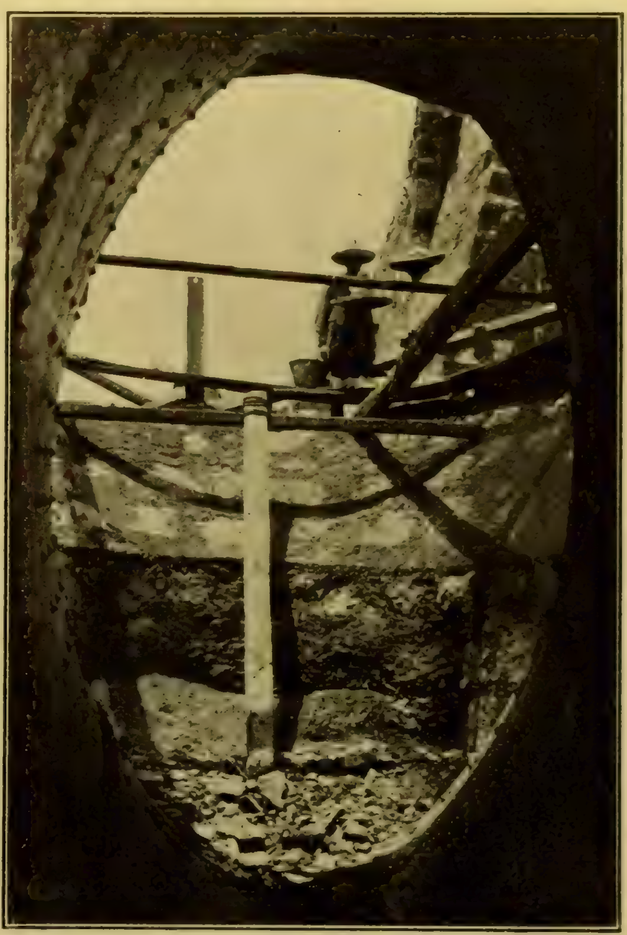
The power house (pages 753, 754,) has masonry walls built of native volcanic rock. The roof is of galvanized iron supported by steel roof trusses and lined with an anti-condensation lining. Its inside dimensions are, length 200 feet, width, 32 feet. The floor is of cement. A low wall separates a length of 40 feet at the easterly end of the building where the transformers are placed which portion is two feet lower than the main room and is provided with drains into the tail race. There



THE SCREEN AT THE PENSTOCK DURING CONSTRUCTION.

are two 10-ton hand-operated cranes which run the entire length of the building over both generator and transformer rooms. The erection of these cranes was an unusually simple matter. They were rolled into place from the surface of the ground, and subsequently constituted the basis of a movable platform upon which the roof trusses were carried to place, as shown on page 753.

The cast-iron branch pipes convey the water to heavy 30-inch gate valves equipped with by-passes. The nozzles are attached to the gate valves. These pipes are made of close-grained gray cast iron and have lip and recess flange joints with lead gaskets and are entirely buried in concrete.



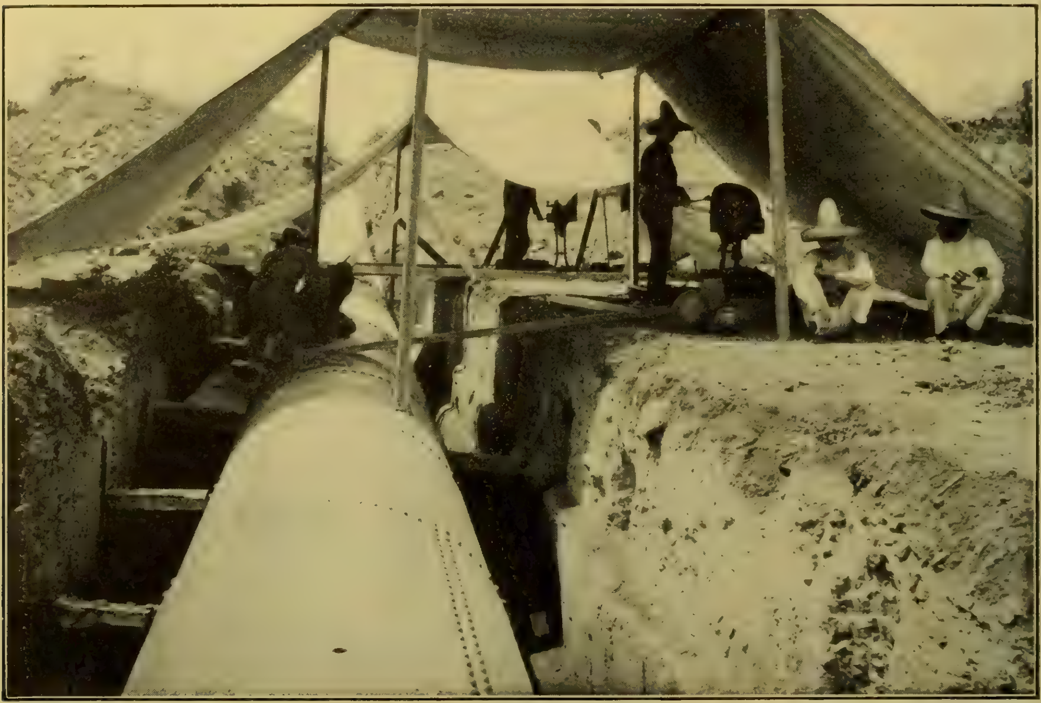
LOOKING OUT OF THE GREAT OVAL SECTION AT THE HEAD OF PIPE LINE NO. 2, DURING CONSTRUCTION OF THE PENSTOCK.

As shown in the plan, the nozzles are curved in form, making a 45-degree bend so as to bring the axis of the jet at right angles to the water-wheel shaft. Each nozzle is provided with a removable tip, of cold-blast charcoal iron, held in place by means of 14 ⅞-inch Tobin-bronze studs with steel nuts. The nozzle is of the needle regulating type, having a core piece movable axially within it by means of which the annular area of the orifice is changed. The core piece is a Tobin-bronze stem with a phosphor-bronze bulb fitting into the nozzle tip. A continuation of the steam through a gland in the convex side of the nozzle casting is threaded, and, by means of a bevel-gear nut operated through a hand-wheel stand, the needle is moved in and out to adjust the quantity of water discharged by the nozzle, so that the maximum economy in the use of water may be attained.

This construction produces a solid jet of good form and of high efficiency over a wide range of discharge. Each nozzle is equipped with a deflecting hood, operated through a system of levers by a governor, for regulating the speed of the generating unit.

The water emerging from the nozzle tips in solid jets more than half a foot in diameter, at a velocity exceeding a mile and a half per minute, with a pressure of 138 pounds per square inch, is projected into the buckets of the water wheels. (Page 755.)

Each water wheel has fifteen huge buckets, more than two feet in width and weighing 254 pounds apiece, made of close-grained cold-blast charcoal iron. The buckets are accurately fitted to the rim of the cast-iron wheel centre and secured thereto by means of two fitted steel stud bolts. The entrance edges are sharpened, the hydraulic surfaces are ground smooth and painted, and each bucket is brought to a standard weight so as to obtain a dynamic balance. The cast-iron wheel centres are machine-finished all over, bored taper, key-seated, and secured onto the projecting ends of the generator shafts by means of a feather and a large bronze nut.

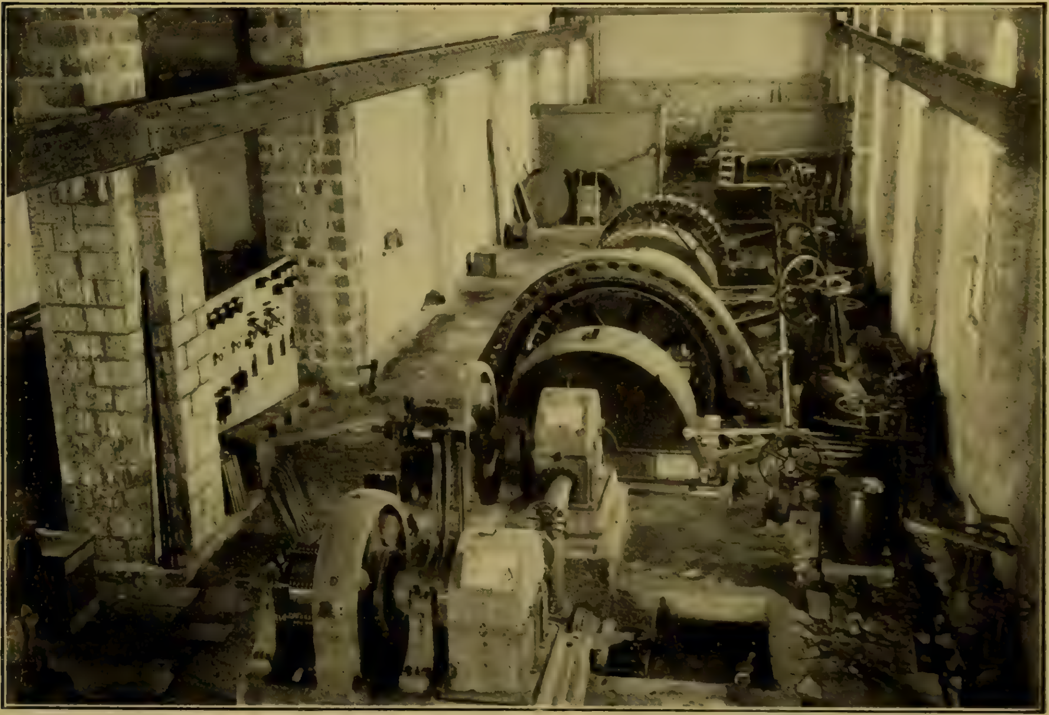


RIVETING UP PIPE IN THE TRENCH. THE HOLE FOR PASSING HOT RIVETS IS SEEN IN THE FOREGROUND.

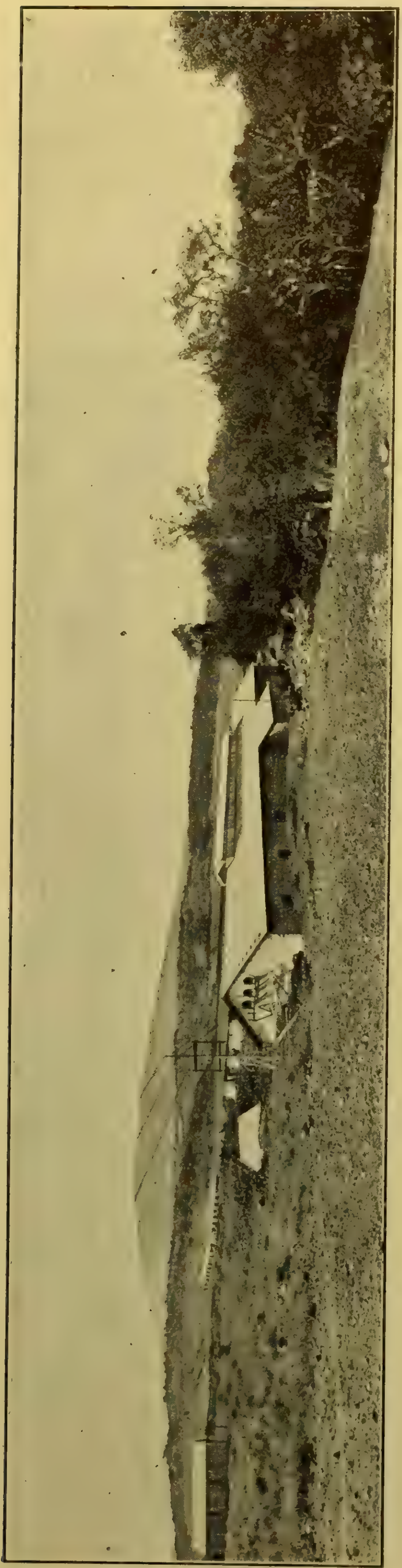
The solid carbon-steel shaft is 12 inches in diameter from the water wheels through the bearings, being enlarged to 16 inches diameter in the middle portion. The bearings are 36 inches in length by 12

SETTING UP THE ROOF TRUSSES WITH THE HELP OF THE TWO CRANES.

inches in diameter, of ring-oiling water-cooled type of special design. The generators are revolving-field, engine-type, 2,300 volt, 3-phase, 60-cycle, 200-revolution machines, rated at 1,250 kilowatts, but designed for a 25-per cent. continuous overload. Their characteristics,



THE INTERIOR OF THE POWER-GENERATING STATION.



GENERAL VIEW OF THE POWER-GENERATING STATION.

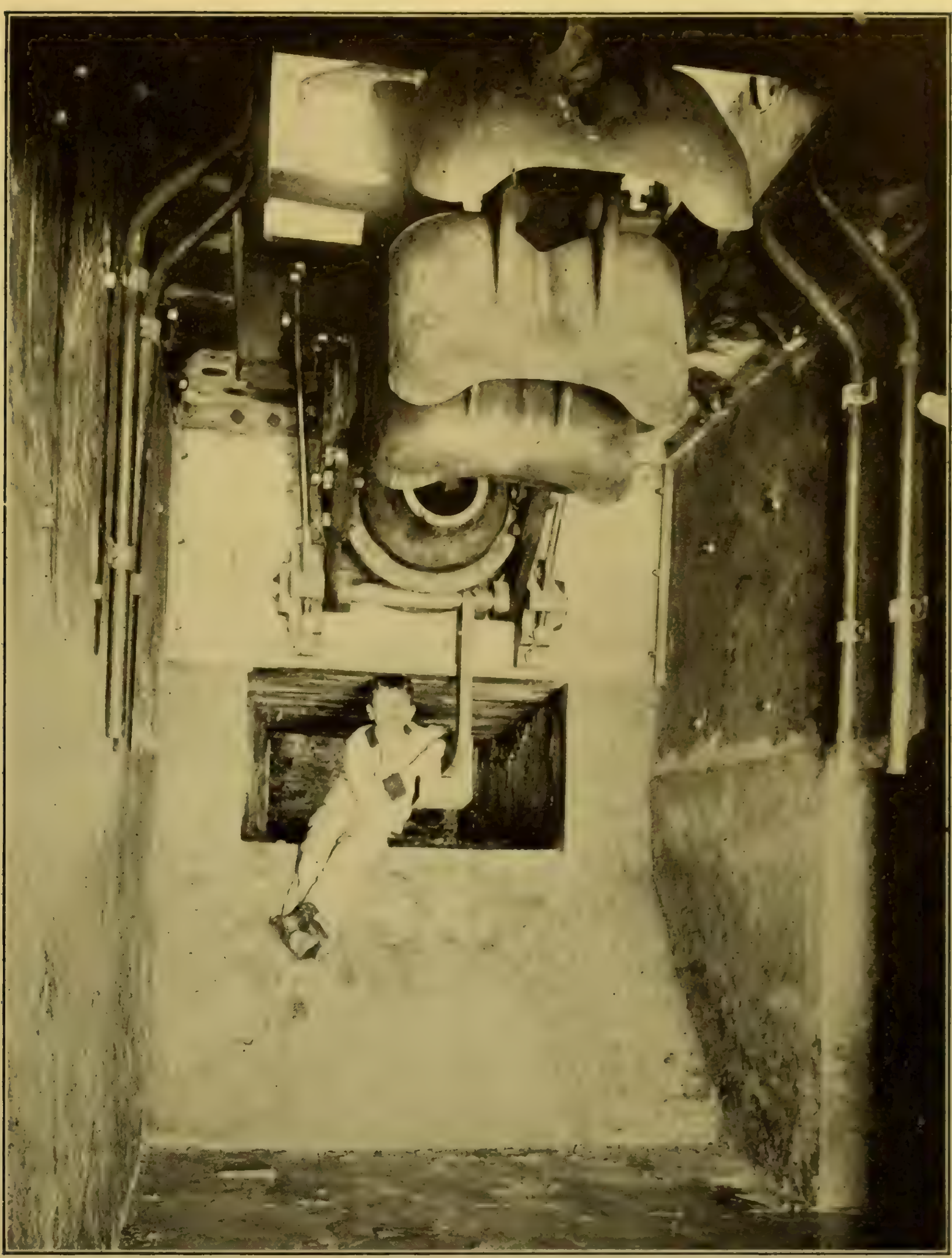
as determined by factory test, are as follows: Full load commercial efficiency, 95.77 per cent.; three-fourths load, 94.92 per cent.

Regulation at full load and 10 per cent. power factor is 4.4 per cent.; temperature rise of armature 21 degrees C. after 6 hours full-load operation.

The total weight of the revolving element, consisting of the field, the shaft, and the two water wheels, is about 50,000 pounds, carried on two bearings. The speed is regulated by means of a governor, operated by an oil-pressure system, actuating the deflecting hoods already described. The governors and the oil-pressure pumps are belted from the generator shaft.

The hydro-electric generating units above described are conspicuous by reason of their compactness and simplicity, there being only the stationary armature, the electric and hydraulic revolving elements mounted on the shaft, and two bearings. The 1,250-kilowatt unit occupies a floor space of only about 17 feet by 25 feet.

Continuous current for exciting the alternators is supplied by two 120-kilowatt 500-revolution self-contained hydro-electric units each of sufficient capacity to excite the four generators, so that one exciter is a spare. The exciter base is extended so as to receive the water-wheel housing. The water wheel is mounted on the extended end of the shaft overhanging the bearing. Water is supplied to the wheel through a hand-regulating needle



NOZZLE TIP, DEFLECTING HOOD, AND WATER-WHEEL BUCKETS.

nozzle, being conveyed from the main branch pipe. The current is conveyed from the machines to the switchboard, and thence to the step-up transformers, through lead-covered rubber-insulated copper cables laid in shallow covered ducts in the cement floor. The current passes from the generators through 600-ampere oil-break switches, each installed in a separate concrete compartment, to the 2,300-volt bus-bars.

The field rheostats are supported on 4-inch I-beams above the

JOINING TWO LENGTHS OF CABLE IN THE FIELD.

switchboard and are operated by means of chains and sprocket wheels. The bus-bars, oil switches, and wiring for the instruments are all back of the board and out of the way, being located in an alcove on the north side of the building, as shown on pages 753 and 754. The switchboard has seven marble panels, one for each of the generators, one for each exciter, and one for two step-up transformer circuits.

From the switchboard the 2,300-volt current is conducted to the 1,800-kilowatt static transformers, where the potential is raised to 60,000 volts for transmission. The transformers are delta connected on the low-potential side and "Y" connected on the high-potential side, the neutral being grounded. The efficiencies of the transformers as determined by factory tests are as follows:—

Full load, 98.295 per cent.; three-fourths load, 98.028 per cent.

THE TOWER, SHOWING INSULATORS, CROSS ARM, AND ROLLERS FOR STRINGING CABLE.

The transformers are of the oil-insulated, water-cooled type; the tanks are 12 feet in height and occupy a floor space of 3 feet by 6 feet. From the step-up transformers the current is conducted to the transmission line, the wires passing out of the building through circular openings in the wall to a set of 60,000-volt disconnecting switches mounted just outside of the building, and thence to the first tower of the transmission line, as shown on page 754. On the inside wall of the building three rows of

60,000-volt lightning arresters are mounted, being connected through switches to the outgoing leads.

The 101-mile, 60,000-volt transmission line differs materially in design from any line heretofore constructed, notably in the use of a hard-drawn copper cable instead of the usual solid conductor, metal pins, cross arms, and towers for supporting the insulators, and unusually long spans.

The conductors are 19-strand, hard-drawn copper cables approximately ⅜ inch in diameter, equivalent in carrying capacity to a No. 1 B. & S. G. wire and weighing 1,340 pounds per mile. This type of conductor was finally determined upon, after much study and many tests, because of its high conductivity, flexibility, and mechanical strength, the wires composing it having a tensile strength of over 55,000 pounds per square inch. The cable was made and shipped in lengths of about two miles. The joints were made with special copper-tube connectors, 12 inches long and elliptical in cross section. The two ends to be joined were passed through the connector in opposite directions, and three complete twists were given by means of special wrenches. The photograph opposite shows a joint partly twisted. No soldering was done. The cables are placed in grooves on top of the insulators, 78 inches apart, at the points of an equilateral triangle, and are tied in with No. 14 soft-copper wire. In stringing, the cables were pulled over the cross-arms on rollers as shown on page 756, below. Diagrams were prepared showing the proper sag to be allowed for various temperatures and for spans up to 1,320 feet, based upon a maximum strain of 20,000 pounds per square inch. The calculations include an allowance for the mechanical elasticity of the cable.

The insulators are larger, heavier, and better than those generally used, and were required to stand a test potential of 120,000 volts for five minutes. They are over 12 inches in height and 14 inches in

THE INSULATOR, SHOWING ITS CONSTRUCTION.

diameter, and weigh about 15 pounds. They are made of porcelain with a brown glaze and consist of four parts, as shown in cross section on page 757. The top and the first petticoat were glazed together in the kiln, and the other two joints were made with neat Portland cement. The pins were likewise secured into the completed insulator. The pins are of cast iron, conical in shape and cored hollow. The pin which carries the top insulator has an enlarged base, threaded on the inside, and is screwed on to the end of the 3½-inch extra-heavy pipe, which projects from the top of the tower. The pins which carry the lower insulators have rectangular bases securely clamped between the ends of the 4-inch channels which constitute the cross arm.

The towers are special 40-foot, four-post, galvanized-steel structures, made of 3-inch by 3-inch by 3/16-inch angles, braced and stayed with smaller angles and rods. Each post terminates in an anchor consisting of a piece of angle iron 30 inches long secured at right angles. The towers are spaced 440 feet apart, twelve per mile, except near Guanajuato, where the nature of the ground necessitated the use of a few 60-foot towers and spans up to 1,320 feet in length.

Two No. 9 B. B. double-galvanized iron wires for a telephone circuit are fastened on the transmission towers ten feet below the copper power cables. They are tied to regular glass insulators placed on 12-inch painted oak brackets bolted to the tower legs. The telephone wires are transposed one complete revolution every four towers; the power cables are not transposed. High-resistance instruments are used, and the telephone service is quite satisfactory.

The line is divided into four sections of about twenty-five miles, and is in charge of a superintendent whose headquarters are at the middle storehouse. At each of the three division points there is a first-class storehouse, a set of 60,000-volt disconnecting switches in the main line, a line foreman, and patrol man, both mounted. In the middle of each section there is a second-class storehouse in the care of a mounted patrol man.

At Guanajuato the transmission line cables enter the sub-station through a set of 60,000-volt disconnecting switches the same as at the generating station.

The Guanajuato sub-station is a handsome stone building with brick trimmings and a flat roof, standing in a beautiful grove of trees. The dimensions of the building are length, 113 feet, width, 89 feet. There is a central portion two stories high with well proportioned one-story wings on either side. One wing contains an office for the

THE SUB-STATION AT GUANAJUATO.

general manager, a drafting room, an accounting room and a reception room. The other wing is fitted up for a repair shop and store room. The central portion contains the transformers. A 10-ton hand-operated crane runs over the shop and transformer room, passing through folding iron doors. The electric current enters the building, passes a set of lightning arresters with disconnecting switches, like those at the generating station, and goes to a bank of oil-insulated, water-cooled transformers where the line potential is reduced to 15,000 volts. These transformers are rated at 970 kilowatts each. Their efficiencies as determined by factory test are as follows:

Full load..............	98.193 per cent. efficiency
Three-fourths load	97.93 per cent. efficiency

From the step-down transformers the cables pass through ducts under the floor to the switchboard, thence to the six 15,000-volt, three-phase distributing circuits, each of which is equipped with lightning arresters and air-break switches with tube fuses.

The solid copper wires of the distributing circuits are carried on 5¼-inch brown porcelain insulators, supported on wooden pins in wooden cross arms on square yellow-pine poles, 30 to 35 feet in height, 9 inches by 9 inches at the butt, and 7 inches by 7 inches at the top. The iron telephone wires are carried on the same poles, but are frequently transposed. The power wires are not transposed.

At the mines and mills where the electric power is used the potential is reduced in three-phase transformers from 15,000 volts to 460 volts for motor service. The Guanajuato city two-phase, 2,100-volt lighting system is supplied through a bank of 150-kilowatt, three-phase to two-phase transformers with a feeder regulator in each phase.

A branch line extends to Irapuato, the "Strawberry Station" on the Mexican Central Railway. The Irapuato sub-station is a brick building equipped with 60,000-volt disconnecting switches and lightning arresters and the following oil-insulated, air-cooled transform-

HAULING THE GENERATOR ARMATURE THROUGH THE STREETS OF ZAMORA.

ers: Four 200-kilowatt line potential to 15,000 volts, four 75-kilowatt 15,000 to 460 volts for motor service, two 40-kilowatt 15,000 to 2,200 volts for the city lighting system.

Power is supplied to various small industries throughout the city, including three grist mills, a foundry, a wagon works, a paint factory, and various pumps used in irrigating the strawberry fields.

To the ingenuity of American engineers, backed by American capital, is due this noteworthy development by which the energy of the swift and boisterous Duero River has at last been harnessed, and after conversion into electricity has been transmitted over the 100 miles of intervening country to revivify the mining and other industries of the picturesque old city of Guanajuato, famous for its great mines, which are said to have produced during the past 350 years, about one-fifth of all the silver in the world. Of late years these mines have not been worked to any great extent, largely because of the high cost of power.

The inception and development of this enterprise are due to Mr. Leonard E. Curtis, who had been for a long time counsel in patent matters for the Westinghouse Electric & Mfg. Co., and who had been obliged to leave New York and go to Colorado on account of his health. He was sent to Guanajuato by clients to examine the title to certain mining properties, and it occurred to him that the conditions there were exceedingly favorable for the introduction of electric power if a suitable water power could be found within working distance. He employed a young American, whom he found there, to search for a water power, giving him a radius of 100 miles from Guanajuato to work in. The water power which has since been developed was found, and an option obtained on it during the following year. In the meantime Mr. Henry Hine, under whose management the Stanley Electric Manufacturing Co. had been built up, and who had resigned his position in that company when the ownership of it changed hands, had joined Mr. Curtis in Colorado, quickly subscribed the necessary capital, subject to an engineering examination, which was made by Mr. Robert McF. Doble, of San Francisco; Mr. H. H. Filley, of Kansas City, and Mr. Charles T. Main, of Boston. Their report was favorable.

The designs and specifications were prepared in San Francisco. The materials came by sea and by land to the railway station at the quaint Mexican city of Zamora, whence they were hauled on wagons. The task of hauling to the construction camp was by no means easy, although the distance was not more than ten miles. The way lay through the city of Zamora, thence to the little town of Jacona, and thence about six miles along the State highway to the construction camp at the little Indian village of El Platanal, where the power generating station is located.

American mules were purchased and specially designed American wagons were provided in order that adequate means should be at hand for carrying the heavy parts to their places. The roads through the country are mostly over black adobe soil of indefinite depth. A few rainy days are sufficient to convert such roads into regular quagmires. The haul through Zamora and Jacona was by far the worst part, since the streets had been improved (?) by a pavement of stones of no small diameter, and in spite of the wide tires the wagons would break through the pavement into the underlying mud during the short intervals of time allowed for the animals to rest. The cut opposite shows a team of twenty-one mules hauling the lower half of the armature of one of the generators. To get this load safely over the city streets required the combined efforts of two American superintendents and ten peons, all directly interested in some way in the moving of the load. Two wagons followed carrying jacks, block and tackle and tools for making repairs en route, forming in all quite a procession.

The short time in which this project was executed is most remarkable and is characteristic of the management. The preliminary examination was made in March and April, 1902, construction was begun in the fall of the same year, and in October, 1903, the plant was put into regular operation. This undoubtedly establishes a record in Mexico for rapid and efficient execution of construction work of a technical character and of considerable magnitude, especially in view of the fact that the work was completed within the estimates of cost.

ORGANIZING THE MACHINERY-SELLING DEPARTMENT.

By Russel M. Seeds.

While Mr. Seed's topic is frankly commercial rather than technical, he makes so admirable a presentation of a matter which is integrally connected with modern industrial success that we deem it well worthy a place in our works-management series.—THE EDITORS.

UNQUESTIONABLY the average house building heavy machinery regards the whole advertising business as an expensive nuisance, necessary because competitors do it, but none the less, a source of great expense and bother. With the notion of "holding down" this expense to a minimum, the advertising was once handled by the head of the house, or delegated by him to one of the more responsible officers; and this plan is still followed in a number of concerns. It is distinctly bad. When the man handling the advertising has more important and more immediate duties to absorb his attention, he is quite apt to throw away more money than would pay the expenses of a well-organized advertising bureau that would be a proven profit-bringer, instead of an uncertain expense. In the advertising proposition of any concern seeking to spread its trade throughout the country or to increase an already widespread business, there is plenty of work to keep one high-class man and several clerks busy. Logically this work should include the making of catalogues, the procurement of photographs, wash drawings, and engravings, the contracting for space and preparation of space advertising, the collection of lists and preparation of letters and other matter for direct advertising, and the collection and following up of special information that may be developed into inquiries.

It is the business of advertising to locate the customer and develop an inquiry. More than that it cannot do toward placing the product of the builder of heavy machinery. It cannot "create a taste" for heavy machinery. There must be an existing need. The man with the need must be discovered; and when he has made his needs known and asked for quotations, advertising has gone as far as it can go. It then becomes a question for the salesman to handle.

The house feels the need of high-class salesmen, because it understands what class of men they come in competition with in their work.

The house should understand, and the advertising man himself should understand, that every catalogue, every space advertisement, and every letter he puts out is quite likely to meet in competition the work of very superior brains. There is always someone among competitors who does some part of the job, if not all of it, better than he. It is not a position to be held by a clerk, but by a man of intelligence and judgment, supplemented with a certain amount of special knowledge.

The status of the advertising man and his bureau in the business is something of a mooted question in a good many machinery-building establishments, and this is largely the fault of the advertising man himself. As a general thing, he is given a free lance and an uncertain status at the start, and he either develops into a rather expensive clerk or an essential part of the business organization, according to his ability and deserts. Unquestionably the advertising bureau should be a part of the sales department, and its chief should report to the head of that department. Lack of harmony between the two is fatal, and the best way to obtain harmony is not by making co-ordinate departments to handle propositions between which the dividing line is hard to define. Preferably the advertising man should owe his employment to the head of the sales department. The latter will be wise if he selects a good man, takes the trouble to understand him and his work thoroughly, and then gives him as much leeway as the circumstances and the character of the man will admit. The advertising man should be in close touch with the engineering department and have early knowledge of all changes of standards, and he should know enough about costs and prices to know what goods carry a profit and what do not. He should know enough of the finances of the concern to know how heavily it can afford to gamble from month to month on advertising. An "advertising appropriation" is a mistake. It is never possible to guess the right amount in advance, and thus a fixed appropriation is either a dangerous temptation, if it be too large, or an annoying limitation, if it be too small. It is all right to have it as a myth, for often the easiest way to refuse an embarrassing request is to hint at an exhausted appropriation; but, as a matter of fact, there should be no appropriation. Above all, the advertising man should know the selling proposition of the house from top to bottom and should be in daily touch with the sales. Direct selling may mean one method of advertising, and an agency system quite another, while selling through the general jobbing trade might mean still another general advertising plan. And, if he is to know when, where, and how to advertise, he should know in a general way what sales are being made daily and where the goods go. He should, of course, review all the inquiries of the house daily, and have a quick method of determining whether or not a particular inquiry originated from advertising, in order that no inquiry be delayed more than a few minutes on its way to the trade desk. A list of the inquiries submitted to him is not sufficient. There are points about the letter and even the letterhead that may be valuable to him in his efforts to trace. He should also have the fullest co-operation of the head of the sales department in establishing a simple system of following such inquiries as he traces to advertising, until they are either sales made or sales lost. Finally, he should be required to account for every dollar expended for advertising in any form, and to show at least twice that much money brought back in the shape of profits on goods sold on inquiries indisputably traced to advertising. It may be a bit unfair to base his returns on sales, instead of on an agreed percentage of acceptable inquiries, but it has a tendency to make him a constant and intelligent critic of the selling methods, and honest criticism is a wholesome tonic in any business. This requirement that the advertising man "make good" also has a remarkably conservative influence on his judgment. It is not by any means an impossibility in heavy machinery, and the man that cannot do it ought to get out and try something else.

After the man has been chosen, the scope of his work decided upon, and his status in the business organization determined, how shall he go about his work? First, he must know the product of the house and its field very thoroughly. He should not only know all the details of the machinery built by his concern, but he should also know how they compare with similar features of competitors' goods. He should know in what kind of plants his goods are used, and he should know at what seasons such plants plan improvements and in what parts of the country these plants are located. He should know who buys the goods, and who tells the buyer what to buy, and who tells this man what to tell the buyer. What manner of men are these, what are their habits of thought and observation, what will interest them most and how best can they be reached? All these are very interesting and very important questions, and in their partial solution lies the reason why the man who has grown up with the business frequently does much better advertising for a machinery house than can possibly be done by the professional advertising expert. The men he appeals to are usually busy men and men of sense. First of all they want a good, clear picture of the machinery and some indication of its capacity. The rest must be a truthful message, briefly told, without either startling or humorous effects, or anything that smacks of the catch-penny.

The advertising man should be equipped with a fairly thorough knowledge of photography, of the making of wash drawings, of engraving and of printing. All these people do better work when the man they are doing it for understands what they are doing and cannot be fooled. If a bad job comes from the press, he must know whether it is the fault of the photographer, the artist, the engraver, or the printer, and should know just how and where he "fell down." At the same time he should bear in mind that criticism properly made encourages, while the other kind kills; and he should further remember that in all this class of work, where there are a thousand and one chances to cut, one seldom gets more than he pays for in the way of quality. Cheap engraving and printing always show their price very plainly—and a house is better off with none at all. A house is known by the character of its catalogues and printed advertisements and these carry a very well-defined impression of the grade of goods it turns out. Dignity, elegant simplicity, clearness, and perfection of detail are the points to be desired.

Space advertising is the knottiest problem with which the advertising man must deal. It is here that the great opportunity for waste of money or for profit lies. At best the effort to trace results is unsatisfactory. Such keys as post-office-box numbers, street numbers (outside the largest centers of population) or department designations, are wasted. The buyer is usually intelligent enough to know that your mail, addressed to your city, will reach you and that an inquiry will reach the proper department in due course. He will not take the trouble to help you sort your mail. There are, however, ways of keying, such as putting a different designation under the cut used in each paper, that serve fairly well. The first question in space advertising is that of mediums. It is easy to learn what are the leading periodicals in each field—and there are never more than two or three at most. The new ones and the little fellows are wasted money and time, no matter how low their rates. A considerable part of the value of space advertising is the impression of your standing in the trade it makes upon your public, and this kind of value can be given only by mediums of established reputation and dignity. If you have anything new to introduce, exploit it fully with all the space necessary to show and explain it. Otherwise, space enough for one or two illustrations and a full list of your product is sufficient. And there should be a change with every issue. This takes time and a system of keeping track of things, but it is not difficult.

A big question in the space advertising is whether the advertiser shall endeavor to cover all the fields in which his machinery is used through the journals representing those fields, or confine himself to the journals representing his own line of manufacture. We studied questions of selling long before we studied advertising, and finally reached the conclusion that people with large propositions, like machinery houses, wholesale houses, and the like, had better congregate in districts, for buyers would come where they could get the most competition; while retail grocers, druggists, and the like, should scatter out among the buyers' homes. If the proposition is small, with widespread consumption, scatter the advertising; if it is big, confine it to your own line of papers. The manufacturer seldom buys machinery without consulting the mechanical engineer, stationary engineer, architect, or millwright, and these read the periodicals devoted to engineering.

If the new or weak periodical is of little value because of its small standing, how is it with the "sporadic" publication, the one-time effort that has no standing at all? These propositions are the terror of all intelligent advertising men. If the head of the house wants to put some money in a church-fair or labor-day programme, if he wants to appear in "Our Local Industries" or sign a "Business Men's Proclamation," or spend money on some other fake, he has the right, of course, to do it, but it should be charged to donations, not loaded on the expense account of the advertising bureau.

A word about the much overworked "write-up." If you have something new and interesting, the papers on your list will usually be glad to use it in their reading columns, but they do not want to—and the good ones will not—describe things that have been on the market for months or years, nor is it of any interest to anybody but your competitor to learn what sales and shipments you made during the past month.

There is, however, one form of the "write up" that is made by the publication itself, to which the advertising man should give all the attention possible. It comes, like angels' visits, rarely and unexpectedly, but when its full advantage is reaped it is worth more than all the advertising space money could buy in that particular periodical, if it be one of the better class. For the purpose of some general article he has in mind, the editor sends out a request to a few leading concerns for photographs and data describing their product or some part of it. Since the article is to go into the body of the reading pages of the periodical, it will be read and it will carry the impression that the machinery houses mentioned therein are the leading ones in the trade. There is nothing better in advertising than this, and it behooves the house not to dismiss it by mailing a catalogue covering the point. The editor is quite apt to be as lazy as you are, or he may not be sufficiently familiar with your catalogue or with your trade to dig out the data he wants. Study intelligently what he wants and give it to him in the shape he wants it. Get good photographs, if you have not them at hand, and put on the back of each the name of the machine, its capacity, and other essential details, as well as your firm name. He has probably asked others for similar information, and he cannot know by instinct the photographs sent by one house from those of another, nor does your letter of advice, sent under another cover and arriving at a different time, help in the identification. It is well worth spending time and money to do this right, for it is the best advertising that can be got in any way.

Not by any means the least of the advertising man's work is the building up of a proper system of direct advertising. Up-to-date catalogues should be in the hands of every man interested in any way, or likely to be interested, in the machinery of the house. These lists are hard to get and still harder to keep corrected, but the returns are worth the effort. It pays to keep in constant touch with a very large number of such people by means of a systematic correspondence, and it also pays to gather special information from all possible sources about new plants, replacements, etc., and to endeavor by correspondence to verify this information and develop it into inquiries.

Advertising, if intelligently and industriously done, can be made a sure source of profit, instead of an expense with intangible hopes of profit—and the only kind of genius it requires is a fund of common sense and a capacity for a great deal of hard work, coupled with a systematic method of handling a large amount of detail.

THE ENGINEER, THE ARCHITECT, AND THE GENERAL CONSTRUCTION COMPANY.

By Reginald Pelham Bolton.

The disorders and abuses cited by Mr. Bolton could not fail to be a menace to the welfare of both the professions involved, and to the best interests of the community at large. In presenting the article, the editors are actuated by the same motive which inspires the author—the hope that a straightforward and plain statement of the matter may work for the removal of the evils, and the readjustment of conditions on a sound and honorable basis.—THE EDITORS.

THE architectural profession has not infrequently recognized its responsibility for the results of its professional work, and has advanced in many ways along lines of modern development. But it has curiously failed to recognize its responsibility in another and more important respect, namely, that of the acceptance of fees in payment for certain technical and artistic work which its members are not qualified by training to execute, and in which they are not expert in the same sense as they are in connection with actual building design. The position occupied by the profession in this regard is not logical, and has brought about a very disastrous state of affairs as regards their employment in the largest building enterprises.

As the logical reason for the employment of professional ability in the design of a building, in place of the employment of contractors or builders for the purpose, it is maintained by the profession that their members are a trained body, expert in the design and proper construction of the work they undertake to plan, uninfluenced by the considerations which affect the contractor or builder, and capable of giving economical and independent advice to their clients.

The client, it therefore follows, in employing an architect, engages and pays for a personal ability and technical knowledge of the subjects under consideration and is entitled to a receipt of that personal capability and technical information in each branch dealt with.

If, therefore, the architect does not possess expert knowledge on any one branch of his undertaking—and no one can expect that any one of that wide profession should be so fully informed—he is under moral obligation to supplement his own deficiency in respect of any particular item involved—such as, say, sculpture, modeling, decorative effects, landscape gardening, sanitation, boiler practice, chimney design, electrical equipment, heating, ventilating, hydrostatic, elevator, foundation, steel construction, or other modern requirements—by the equivalent expert and equally independent knowledge of others; otherwise he is not giving his client value for his engagements.

In other words, architects are paid for professional knowledge and experience upon all parts of the work they undertake, and cannot honestly accept pay for their services as amateur sculptors, artists, engineers, plumbers, and for amateur opinions upon technical subjects. Yet too many of them not only do so, but still adhere to the old practice of obtaining information, guidance, proportions, even their plans and specifications, from contractors and prospective bidders.

As regards engineering work, there are a few architects who by reason of a certain amount of habitude, possibly in some cases of a certain amount of training, possess a familiarity with some sanitary and engineering matters. But would they, if deprived of their architectural practice, undertake with that amount of knowledge to enter upon independent practice as experts in those lines?

In other words, will any architect assert himself to be as fully qualified in these matters as he professes to be, and is, in building design and construction?

Recognizing the necessity of doing something, but desirous of avoiding the cost of employment of ability of a character and cost equal to their own, a number of architects have proceeded to a course which has proved peculiarly adverse to the interests and credit of the profession. They hire inadequate and often inexperienced help in the shape of assistants or draughtsmen, and put them forward as their substitute for technically trained expert assistance. One of the foremost firms of architects in the United States have in their employment, and put forward as their "consulting engineer," a very worthy, and in his own line deserving, man whom they took out of an engine room. There are several others who pay their "consulting engineers" in their office from $20 to $30 per week, and permit this class of experience to pass upon and decide the important operating expenses of their clients. Such men are not only incompetent in the direction of knowledge, experience, or ability, but an injury is inflicted upon the client which often reflects back upon the architects, by placing such a class of men in control of matters where large sums of money and many competing and unscrupulous interests are engaged.

The very essence of the employment of professional men is that their "standing" shall protect the employer from corruption and undue influence; and in passing over any part of their engagement to a lower class of employed and often underpaid labor, the architects very seriously compromise their employer's interests. Even when an independent engineer is employed he is often made to feel that he is only the agent of the architect or is placed under obligations to make his designs coincide with the architect's views. The results are to be seen in many otherwise well-considered installations.

There are eight hundred and fifty practicing architects in New York, and there are seventeen independent consulting engineers employed on such cognatic work, where there should be plenty of inducements and work for ten times the number. The architectural profession have had this matter drawn to their attention by several engineering societies, and have not only failed to correct their false position, but have embodied it in the provisions of their form of professional contract. As their self-sufficiency evidently renders them deaf to the calls of plain dealing, it is necessary to direct the attention of those who employ them to the matter, so that the existing system may perhaps be remedied from without. I shall not lay myself open to any charge of one-sidedness, but freely admit that there are some engineers posing as architects to whom the same consideration can be inversely addressed. But it is to the general credit of my profession that they are an extremely limited number.

It is in connection especially with steam apparatus that this matter assumes peculiar proportions, for in this the owner's pocket is particularly and permanently assailed. If a few personally conducted parties of steam users could be taken through some of the most modern firerooms in New York they would certainly be convinced of the desirability of employing engineers on engineering work. A trip up Broadway would reveal boilers in dark and stifling sidewalk vaults which are a menace to public security, since boilers so placed cannot be properly maintained in security; boilers far away from the chimney, necessitating horizontal smoke connections, in one case 225 feet long; boilers, as in one well-known and widely illustrated building, so badly placed and connected that when steam is raised in one the expansion pulls the piping off the other, or, as in one of the largest insurance buildings, placed in the same room as the machinery, with space for only one day's fuel. Such instances could be multiplied.

Owners are of course largely to blame. But they do not realize what the position is. The mechanical plant in a large office building is worth from $60,000 to $150,000. On this an architect commonly receives his commission of 2½ or 5 per cent., or from $1,500 to as much as $7,500. His outlay in respect of its design is frequently nothing, the whole being obtained from contractors.

The steel structure may be competed for by more than one firm of contractors, but each maintains its own drawing office, sometimes employing as many as 100 to 150 draughtsmen, the cost of which labor is added to the price; and thus the planning of this part of the work is frequently paid for by the owner of the building twice over.

The Building-Construction Company.—The unsatisfactory conditions of service, as offered by the majority of the architectural profession, have led to the introduction of a recent development of the pretentions of the builder to the possession of the facilities of the architect, and for this development, directly hostile as it is to their own pretentions, the architectural profession have themselves, in their persistence in the foregoing practices, entirely to blame. I state this fact from personal knowledge of the reasons which induced the introduction in New York of the present system of general construction, the foregoing conduct of the architectural profession having been given to me as the cause by two of the leading concerns against whom the architects of New York are now loudest in their denunciations.

By dint of liberal assertion, of active exertion on the part of young and alert employees, and of constant iteration of architectural shortcomings, the construction companies have plucked the ripest plums from the building orchard. They have calmly adopted the plans of architects, without credit or thanks, have walked off with their clients, belittled their abilities, thrown doubt on their capacity, sneered at their rectitude, and cold-shouldered their approaches to any understanding.

Their particular facility is that they, for a covering figure, can carry out all architectural detail and engineering work without cost and with their own trained staff. This would be an excellent idea, if the staff were of that character; but in point of fact, they have not yet grasped the fact that it would pay them to employ the highest class of professional ability; and therefore the men employed by them in the work of design are often either small contractors, or are assistants of the same order as those to whom I have referred as being employed by some of the architectural profession. If the scope of these powerful concerns should eventually fully cover the field of building operations, the profession of architecture would be very completely visited for its shortcomings, since the avowed idea of the construction company is to allow the architects no more than the opportunity of producing general designs to be by them detailed and developed; but so far, owing to the very similar class of intelligence applied to their work of detail design, the result has often been poor architecture and more often still poorer engineering.

In respect of the latter, I regret to say that since the operations of these construction companies began, no advance whatever has been made in the improvement of the interior engineering of the buildings they have handled. In point of fact, their practice at present is the installation of poorer designs of mechanical equipment than were generally discredited before their methods obtained an ascendency in modern building operations.

It is but a natural result of such a system that this should be the case. A general contract for a great building is made on a condition which is the essential feature and object of the employment of a general contractor. It is that a building of a certain character, often identified only by a mere sketch or outline, or even by a partial reference to some existing building of a more or less similar type, shall be erected within a certain period for a certain sum, without any extra charges. Any attempt to introduce any detail of conveniences, of desirable materials, or of particular requirements, is met and combatted by the objection that the builder must have a free hand in selection or in dealing with competing manufacturers; otherwise the cost will be increased, or the time limit will be exceeded, or labor trouble may ensue. So the owner signs away his money and gets in return a complete structure, it is true, such as his picture showed, which is however built of the material, equipped with the class of apparatus, proportioned to the extent of liberality, and constructed by the class of labor, which have best suited the policy or profit of the contractor. If by the inducement of the needs of this building a gain can be made in another; if by the sacrifice of a detail in one an extra can be avoided in another; if by diverting proper labor from one, less competent or cheaper labor can be utilized in another—then these policies are open to adoption, are liable to be adopted, and are and have been in many cases adopted.

As to the designing work produced under this system, it is inferior and is done by inferior help, whose efforts are subordinated to the one predominating consideration of avoiding all avoidable cost, while at the same time evading the much abused "extra," which in this class of contract, coming directly on the construction company, is of course to be avoided at all cost of sacrifice of efficiency. I will give an instance of an actual occurrence:—

In the construction of one such building it was discovered that by a blunder in reading, or more likely by an error in estimating, no provision had been made for the cost of carrying the decorative "effects" of the two outer sides of the building round its interior sides, which were exposed by the ownership of the abutting property. The difficulty was overcome by directing the engineer to cut down the equipment to a sufficient extent to pay for the deficiency.

The proper equipment was, therefore, cut from two boilers of ample capacity and one spare, to two boilers which, when forced, can just do the work; two generators which unitedly will barely carry 5/10 of the total lighting load, and 6/10 only by overload; the omission of every possible convenience and cross-connection; the reduction of the plumbing and character of the fixtures; and the skinning of the heating arrangements down to the cheapest system. The owners have the satisfaction of knowing that their building is carried out "without extra," and has cornices of the anticipated appearance. But they do not know that they have not only paid an extra in full for the work, but also are paying an extravagant and permanent interest on the achievement, in their coal, repair, and labor bills.

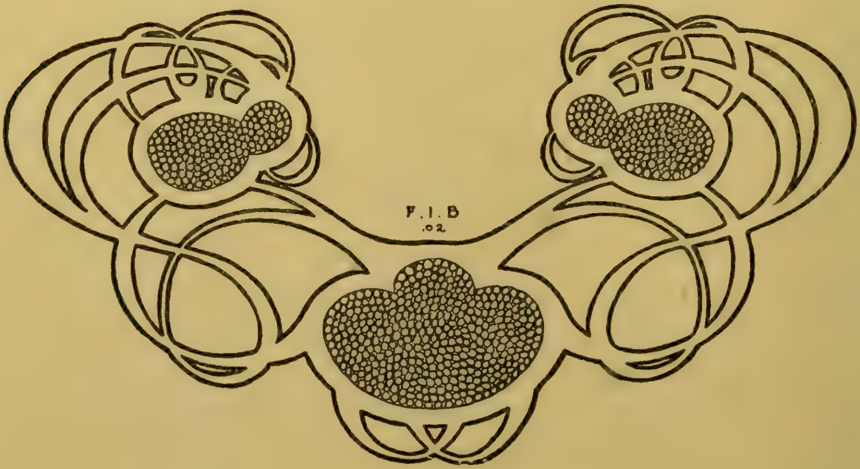
The Owner of Property.—I could multiply these instances, but I do not know if there is any good in attempting to draw beneficial lessons for the education of an educated class which is, withal, too careless or incapable to take elementary precautions as to its own rights and property. One would suppose that a most limited intelligence would enable a property owner to perceive that he is not likely to get something for nothing out of a smart firm of general contractors.

As regards the features of engineering character in their buildings, it might naturally be assumed that men of business capacity and of ordinary intelligence would, in a matter in which they are directly and permanently liable for the cost of results, very closely examine into the conditions surrounding their future outgoings, with the aid of the best technical knowledge available. But that is rarely the case. Such people, when contemplating the construction of a building, are captivated by the ideas of outside design and interior decoration, and are under those influences to such an extent that the hard and mechanical details of engineering operations are uninteresting to them. They are also very frequently dependent in all such matters on some mechanic in their employment, such as the operating engineer or fireman in their own home or other property. These men, when put forward (as they very frequently are) to discuss or suggest or even to proportion necessary apparatus in a new building, do so with the natural subserviency of their class, and come under the architect's or contractor's dominance, their employment in this manner often resulting in worse blunders than would have been the case without their limited ideas, and their liability to accept all kinds of assertions on the part of manufacturers.

Not until it is much more widely understood that the mechanical apparatus in a building is the part of it that directly affects the pocket of the owner, that in it and by it he is constantly being defrauded and fleeced, will the present state of affairs be amended.

I have recently had the opportunity of laying these views before one of the great mortgage-insurance companies, whose action will in future take into account the imperfections and deficiencies of mechanical apparatus in the building in which they take an interest. It may be that others will awake to this, to them, important element, and that through their action careless ownership will be aroused.

Having sat for ten years past between these elements, and having had the good fortune not to fall into the evil graces of either, I am in hopes that my plain speaking will be taken in good part and that all parties will proceed to set their courses with a little more regard for their true interests in this age of engineering detail. And I am thankful to record my knowledge that there are architects who fully live up to their undertakings in the respects I have named, as there are builders who are conscientious, and as there are owners who are capable of appreciating the value of the old saw—"Every man to his trade."



THE TOOL ROOM AND ITS FUNCTIONS.

By John Ashford.

II. THE TOOLING OF MACHINES.

Mr. Ashford's first paper appeared in our special issue for last month—that is, in the Second Labor-Saving Number, dealing with labor saving in works management. In that, Mr. Ashford discussed the general equipment and arrangement of the tool room. In this he takes up its mechanical functions.—The Editors.

IN the article upon the Tool Room and its Functions which appeared in the preceding issue of the Magazine, there were summarised the particular functions that the tool room must fulfill if the work in a modern engineering establishment is not to be excessive in cost. The first of these functions indicated that the cost will be excessive "if the producing machines of the factory are not properly tooled." Thus by inference, the leading function of the tool room should be to provide the necessary small tools, that the producing machines may be operated to their best advantage.

I have already urged that there should be a good tool designer associated with the tool department, his duty, in addition to preparing drawings of tools and appliances, being to keep a register of those made and to arrange where they should be kept, and to decide the identification and location marks to be put upon them. This draughtsman should have a clear conception of a comprehensive tool scheme, and he should have a hand in determining the machining processes and the machines to be installed in the factory. By the exercise of a little foresight in the tool scheme many after difficulties and expenses may be avoided.

Developing this idea somewhat, the first important point that I would like to press home is the matter of *interchangeability* in tools. This to too often neglected, although of importance equal to the standardisation and interchange of parts for the machinery to be manufactured, and consequently much money is literally thrown away by the unnecessary duplication of tools and in delays while they are being sharpened, adjusted, or repaired.

That the output of the producing plant may be brought up to its maximum, the machines should be in actual operation doing useful work of production for as nearly as possible 100 per cent. of the working time. When a lathe is being used to turn up its own centres the work done may be useful, but it is not producing an article for sale; therefore, in the meaning of this discussion it is not doing *useful work of production.*

Speaking of lathe centres, it is too often found that the centres of one lathe cannot be tranferred to another; consequently, they have to be turned in the lathe to which they belong and this becomes tool jobbing. Anything that is produced by *jobbing*—that is to say, an odd item at a time—is always more costly than the production of a number of parts at once, by properly prepared methods and appliances. Thus, for a shop having several hundred lathes, it would be less costly to keep the centres in good working condition if they all had similar shanks, so that they could be made and repaired, a quantity at a time, in the tool room. A constant taper throughout for these and several standard sizes would make it possible to keep them in proper repair at much less cost, and at the same time prevent the otherwise certain interruption of work in the producing lathes.

The question of tapers for tools needs tackling in every engineering shop, for there are so many different angles found in actual use; it would be a great convenience to users if the various tool makers could mutually agree upon some definite standard. We already have the Morse taper for drills, the Brown and Sharpe tapers used by several firms for arbors, etc., and in addition a multiplicity of tapers by various firms for lathe-centre shanks, boring-machine spindles, etc. Suppose that tapers in drill spindles, milling-machine mandrils, lathe spindles, boring-machine bars, and other cases where needed, were all alike—what a convenience it would be! The tools for any one of these machines could be used on any other without the need of special holders, and the actual numbers and variety of tools required in a shop would be materially reduced; it would be a big step towards interchangeability in tools.

The successful running of a tool department will depend upon the value of the tools it produces. Thus it is advisable, nay necessary, that its product should be of the very best quality that can be made, both as regards material and workmanship. The value of this product will be very greatly enhanced if the department takes all necessary steps to secure real interchangeability, so that it can reduplicate any part or prepare spare details with the certainty that they will fit. To this end the method of producing the tool must be carefully thought out and jigs or gauges prepared for it; these tool-room tools, as we may call them—tools for producing tools—being registered and stored with even greater care than those for use in the shop, and on no account should they be allowed out of the tool department.

To illustrate this point, take a very common instance, namely, chucks for drilling machines. In addition to the pure work of drilling holes, much work to be done upon a drilling machine requires a pulling force towards the drill spindle; for example, the facing of circles round bolt holes on the under side of flanges to receive nuts. For this work an ordinary taper chuck or collet as used for a drill is not enough, as the tool would draw out; consequently, to avoid adding other kinds it is convenient to provide the taper chucks with a holding device such as a pinching screw, a draw cotter, or a plain drilled hole for the insertion of a piece of wire of sufficient strength, of which devices I would choose either of the two latter, preferably the draw cotter. The holes, whether for the wire or cotter, must, in all the chucks and shanks of tools, interchange with one another. This can only be done by using jigs for their production and these must *take their setting,* in both cases *from the tapered portion* of the shanks and sockets to be drilled.

It has already been suggested that it is expedient to use the best material obtainable for the making of tools, for it is a penny-wise pound-foolish policy to put inferior material into any kind of tool. The rate of output from a machine is largely governed by the speed of cutting that the tool will stand; and also, the accuracy of the work will greatly depend upon the ability of a finishing tool to retain its cutting edge and its size. In addition to this, good steel requires less frequent sharpening and so costs less in the tool room for maintenance; thus the use of good material is true economy. Having selected the right quality it is not wise to depart from the brands used, for the different makes of steel require different treatment to get the same results; when the tool-room men are familiar with and understand the working of particular brands to secure the tempers they want, it is but to court trouble to make a change. To have too many sorts about is to open the door for the inadvertent selection of the least suitable for a given purpose. A considerable quantity of mild steel will be used for cutter bars, shanks, holders, etc., and for this a pure mild quality that readily case-hardens will be the most useful. Bright stock, although of handy form, is generally an abomination, for it often has an excess of phosphorus, and when case-hardened it fails to give a good hard skin but becomes very granular and quite short. I have many tool holders, etc., case-hardened that others would leave soft, as they last in good condition so much longer.

For roughing purposes there are many high-speed tool steels on the market, the Sheffield steel makers having concentrated much attention on their development. I have tried many of these, finding them on the average to be most excellent for working mild steel, but they do not show to such great advantage on average British cast iron. The stiffer varieties stand much better on the latter material, and of these I have been very well satisfied with "Novo" by Messrs. Jonas & Colver and "A. W." by Messrs. Sir William Armstrong, Whitworth and Co. Other makes, such as Samuel Buckley's high-speed steel and Messrs. S. Osborne and Co.'s high-speed "Mushet," are very well liked, but I have had less experience with them. With milling cutters and drills made from Novo and hardened at a good red heat in oil, very good high-speed work can be done. It has generally been considered that it would ruin ordinary "Mushet" steel to cool it off, but by treating it with oil cooling at a good red heat it can be greatly improved in its cutting powers. When troubled with a hard spot in a casting that is too expensive to scrap if it can by any means be tooled, I have successfully tooled the job, using common "Mushet" and chilling off the cutting point from a bright red by inserting it in an impression previously made in a large block of lead. For finishing steel it is hard to beat the good old brand of "Huntsmans," a supply of which, together with Messrs. Armstrong, Whitworth and Co.'s Nos. 2 and 4 tempers, I like to have on hand.

No matter how well a tool may be made it will lose much of its value if it take much time or skill to set it for use upon a machine; we should therefore make a strong point of the fact that a tool, however ordinary, should whenever possible be made *self-setting.* Tools, appliances, and jigs, to be ideally perfect, must be constructed so that the veriest fool cannot use them wrongly; for, so long as there are two ways of using, the wrong is sure to be chosen sooner or later and loss will be caused thereby. Parallel with this idea of making tools to be self-setting, we must place the rule that where it is impossible so to make them, a ready means should be supplemented to assist the mechanic in setting and testing the tool when putting it into the machine. It is almost unnecessary to insert a reminder here (though not out of place) to the effect that due regard should be given to the cost of preparing appliances and the saving to be effected by their use, so as to avoid spending money upon tools that can never bring an adequate return. In writing about tools here the assumption is that this will have due consideration, and the tools are deemed to be necessary and profitable at their probable cost.

To give a simple illustration of this self-setting idea, let us look at an ordinary bar and cutter so frequently used on drilling and boring machines. This tool in its ordinary form is a plain bar turned at one end to fit a chuck and with one or more slot-shaped holes through it in which flat steel cutters are inserted and wedged in position. This is well illustrated in Fig. 1, page 781.

It will there be seen that the cutter takes its setting at the back, for which purpose there is a recess in the cutter dimensioned A, that fits upon the bar. Obviously, the part A must be perfectly accurate in both bar and cutter and right central with the bar, for a slight error is doubled in magnitude in the hole produced. The slot must not only be correct in all respects but, particularly at the back where the cutter fits, it must be square with the axis. If due care is given to these small points the cost of maintenance becomes trifling as the cutters can be made in quantities. A good way to deal with these is to prepare blanks, and machine a number together to all dimensions except the over-all length. A mandril similar to a bar with a slot in it is made for use upon the universal milling machine with the dividing heads. To finish the cutter it is put into this mandril and milled to length, the dividing head being used to set the cutter over an amount equal to the angle of relief, and to give the half revolution to bring the other end to be milled. If the knee bracket of the milling machine has a micrometer index to the rise-and-fall adjustment, this method is much quicker than turning to size and afterwards backing it off, for the milling machine does both at once.

The illustration of this bar and cutter is introduced with the further object of showing the kind of standard-tool drawings used by me. The sheets used for the drawings are slightly larger than foolscap and when a number have accumulated they can be bound in book form, for which purpose a blank margin is left. For shop use they can be mounted on stout cardboard. These sheets can also be inserted into the tool register kept by the tool draughtsman, and they can be supplied in books to all foremen and tool-stores keepers for ready reference in case they require to know whether some particular size tool is to be found in stock; when, as its location number is on the drawing, there is no loss of time in getting the tool.

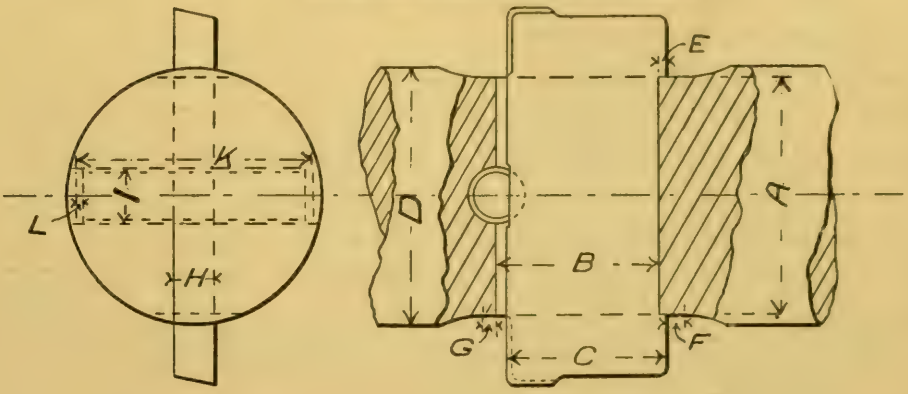
It is a very common mistake to endeavour to run a tool department without sufficient assistance, and the most likely individual to be left out is the draughtsman; yet a man who is not only smart in scheming out tools but who is methodical and consistent in his designing, etc., is particularly valuable. Such a man would naturally observe the types of tools that would be most frequently required in the shops, and he would arrange standard series of such tools upon small drawings like the one shown. For instance, where a number of turret lathes are used for the handling of castings, the thing would be to standardise different types of tool holders, solid and split bushes, drawback arbors with adapting rings and pads, drawback collet chucks, flat drills and holders, oil-supply drills, steadies, single-point boring tools, reamers, and floating holders, etc. For milling machines, a series of arbors, packing pieces, and side, face, and radius cutters, etc., would be standardised.

When arranging a standard series of a particular type of tool, it does not follow that all on the list are to be made at once, but as they are likely to be required. If it is not done, odd tools are made that may be used but once or twice and then put aside or forgotten and the money spent on them is stagnant, if not entirely lost.

That a given piece of work may be machined in the best and cheapest way, thought must be given to it and a series of operations fixed upon that seem the best, having due regard to the machines and tools available. This matter is often left to the foreman of a shop who, with his multifarious duties, cannot be expected to give adequate attention to it; neither can be mentally retain the particulars of processes and tools for a multitude of jobs, nor—for want of time even if he had the memory—can he impart them in detail to the men. It is therefore advisable for the operations to be placed beforehand by the tool draughtsman in conjunction with the works manager, and when fixed upon these operations, together with references to the tools, should be recorded in some permanent manner. The need for this is more particularly apparent when using high-class rapid-production machines with special tool equipment. The operations when fixed upon can be noted, when possible, upon the drawing of the work to be made, but where too lengthy it can be typewritten and mounted upon cards about foolscap size, each of which would have a reference number for indication on the drawing and for filing away. This can be best illustrated by taking some particular case and reproducing the operation lists, drawings of tools, etc. The job selected is a breech block for a 6-inch quick-firing gun, and, considering its shape, the material from which it is made (oil-hardened gun steel) and the accuracy of finish necessary, it forms almost an unique piece of work to tackle on a turret lathe. The job is machined upon a combination turret lathe made by Messrs. Alfred Herbert, Ltd., Coventry, England, and the tools were prepared by the same firm.

STANDARD TOOL LIST No23

BARS AND CUTTERS



	LOCATION MARK	D	A	B	C	E	F	G	H	I	K	L	REMARKS
		1/2	7/16	17/32	1/2	1/16	1/8	1/16	5/32	3/16	7/16	1/32	
		5/8	9/16	17/32	1/2	1/16	1/8	1/16	5/32	3/16	9/16	1/32	
		3/4	11/16	21/32	5/8	1/16	1/8	1/16	3/16	1/4	11/16	1/32	
		7/8	13/16	21/32	5/8	1/16	1/8	1/16	3/16	1/4	13/16	1/32	
		1"	15/16	25/32	3/4	1/16	1/8	1/16	3/16	1/4	15/16	1/32	
		1 1/8	1 1/16	25/32	3/4	1/16	1/8	1/16	3/16	5/16	1"	1/32	
		1 1/4	1 3/16	1 1/32	1"	1/16	1/8	1/16	1/4	5/16	1 1/8	1/32	
		1 3/8	1 5/16	1 1/32	1"	1/16	1/8	1/16	1/4	5/16	1 1/4	1/16	
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		1 3/4	1 5/8	1 9/32	1 1/4	1/16	3/16	1/8	5/16	3/8	1 5/8	1/16	
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		2 3/4	2 5/8	1 17/32	1 1/2	1/8	1/4	1/8	3/8	1/2	2 1/2	1/16	
		3	2 7/8	1 25/32	1 3/4	1/8	1/4	1/8	7/16	9/16	2 3/4	1/16	

FIG. I. STANDARD TOOL DRAWING OF SELF-SETTING BAR AND CUTTER.

The machine will be very well understood from the illustrations given on page 794, but it may be as well to explain that there are two turrets upon separate carriages; the larger one is hexagonal with a list to the back of the machine, so that long tools such as boring bars will clear the capstan handles, etc. The faces of the hexagon when presented to the headstock are central with the spindle. The smaller is square, made from a solid forging, and is mounted upon a carriage with a cross slide. Both turrets have automatic traverse; the square one has a cross traverse in addition, and it is also supplied with a chasing mechanism that works independently of the traverse, an interlocking device preventing the engagement of both at once. The mechanism that withdraws the nut from the leader screw simultaneously withdraws the chaser from the thread, a great convenience in such work as that to be described. A taper turning attachment is fitted to the rear of the machine so that the square turret may be used for taper work.

The blocks of steel, after forging, are rough-turned and oil-hardened, when they come to the machine to be completed so far as turning is concerned. The weight of the block of steel is roughly about 2½ hundredweight, and as it is of taper form it can be most conveniently held in a bell chuck while the interior is bored out, the subsequent operations being done while the block is held from the hole. Speaking generally, where the article to be machined will lend itself to the method, it is best to machine the interior first and then hold it upon an expanding drawback arbor while the exterior is tooled, as the chucking arrangements are more simple, for an adapting ring can be slipped on an arbor more readily than can pads be fitted in a collet or soft jaws be inserted and trued in a self-centering chuck. Errors are also less likely to creep in when the chucks wear.

Before commenting on the tools we will give a bare recital of the operations, the list being suitable for the guidance of the men in the shop. The operations are divided into series, being the work done at the one setting, a number of blocks undergoing the set of operations before the machine is prepared for the next series.

LIST OF OPERATIONS FOR PRODUCING BREECH SCREW OF 6-INCH QUICK-FIRING GUN ON THE NO. 6A HEXAGON TURRET LATHE.

FIRST SERIES OF OPERATIONS.

Hold in large bell chuck, top of chuck to be lifted off, and forging put in with special sling.

1:—Rough-face and rough-turn outside of flange with rough-turning tool No. 1 held in square turret.

2:—Centre from turret with centring tool No. 2 held in special holder No. 3 by bush No. 4.

3:—Rough-drill small hole from turret with straight-flute oil-supply drill No. 6 held in special holder No. 3 by bush No. 8.

4:—Start large hole with tool No. 12 held in square turret.

5:—Rough-drill large hole from turret with oil-supply flat drill No. 10, using oil plug No. 14 held in 3-inch standard holder.

6:—Rough-bore large holes with oil-supply single-point boring tool No. 11, and oil plug No. 14 held in 3-inch standard holder.

7:—Finish-ream large holes with oil-supply floating reamer No. 13 and oil plug No. 14 held in special holder No. 15.

8:—Bore small hole with single-point boring tool No. 16 and adjusting collar No. 17 in special holder No. 18.

9:—Fresh centre and bottom small hole with oil-supply bottoming tool No. 19, oil plug No. 20, and adjusting collar No. 17 held in special holder No. 18.

10:—Rough-drill taper hole with oil-supply drill No. 21, oil plug No. 20, and adjusting collar No. 17 held in special holder No. 18.

11:—Rough-ream taper hole with oil-supply D bit, reamer No. 22, oil plug No. 20, and adjusting collar No. 17 held in special holder No. 18.

12:—Finish-ream taper hole and small parallel hole with oil-supply floating reamer No. 23 in rack-feed holder No. 7 held in special holder No. 3.

13:—Form radius on small parallel hole with radius form tool No. 25 and adjusting collar No. 17 held in special holder No. 18.

14:—Recess with oil-supply recessing tool No. 26 and oil plug No. 14 held in 3-inch standard holder.

15:—Finish-turn and face flange with finish-turning tool No. 27 held in square turret.

16:—Form radius on outside of flange and on edge of large hole with radius tool No. 28 held in square turret.

SECOND SERIES OF OPERATIONS.

Hold on drawback arbor No. 45.

17:—Rough-face with rough-turning tool No. 1 held in square turret.

18:—Centre from turret with centring tool No. 2 held in special holder No. 3 by bush No. 4.

19:—Rough counter-bore with flat drill No. 31 held in 3-inch standard holder by holder No. 32.

20:—Finish counter-bore with finished counter-bore No. 33 held in 3-inch standard holder by bush No. 34.

21:—Rough-turn taper with rough-turning tool No. 29 held in square turret.

22:—Rough-turn parallel part with rough-turning tool No. 29 held in square turret.

23:—Form grooves and face flange with form tool No. 30 held in square turret.

THIRD SERIES OF OPERATIONS.

Hold on drawback arbor as before.

24:—Finish face with finish-turning tool No. 30 held in square turret.

25:—Support on steady No. 37 held in 3-inch standard holder and return taper part with finish-turning tool No. 30 held in square turret.

26:—Return parallel part with finish-turning tool No. 30 held in square turret.

27:—Finish-form grooves and end with form tools Nos. 38, 39, and 40 held in square turret.

28:—Change square turret for another carrying chasing tools and rough-chase taper thread with single-point chaser No. 41.

29:—Finish-chase taper thread with double-point chasing tools No. 42 held in square turret.

30:—Rough-chase parallel thread with single-point chaser No. 41 held in square turret.

31:—Finish-chase parallel thread with double-point chaser No. 43 held in square turret.

FINAL OPERATION.

32:—Hold on drawback arbor as before and relieve taper thread with chasing tool No. 44 held in square turret using special leader.

Turning now to the tools themselves, the bell chuck is bolted upon the flange of the lathe spindle, the flange entering slightly into the back of the chuck for a centering. To facilitate the chucking of the job the chuck is made in two parts with dowel pegs at the joints to bring them truly together. The bolts for the joint are permanently hinged to the fixed part of the chuck. Eight pointed set pins of hardened tool steel are used to grip the job, and for freedom of working these and to facilitate repairs, phosphor-bronze nuts are let into the chuck from the interior. That there may be no difficulty in setting the blocks, the screws are made to project equal lengths from the exterior of the chuck when the job is central.

The first operation does not require comment, but the second draws attention to the special holder marked No. 3 (Fig. 2) attached to the hexagonal turret. The length of such holders as this is occasioned by the necessity to reach over the saddle carrying the square turret. In a lathe of this type the weight of the hexagonal turret with tools attached and its carriage is considerable, and although it can be traversed by hand with comparative ease, yet the mass to be moved prevents anything like sensitive handling necessary for feeding small drills and reamers, consequently this No. 3 holder is provided with a handle feed for drills. A pinion is seen in the drawing of the

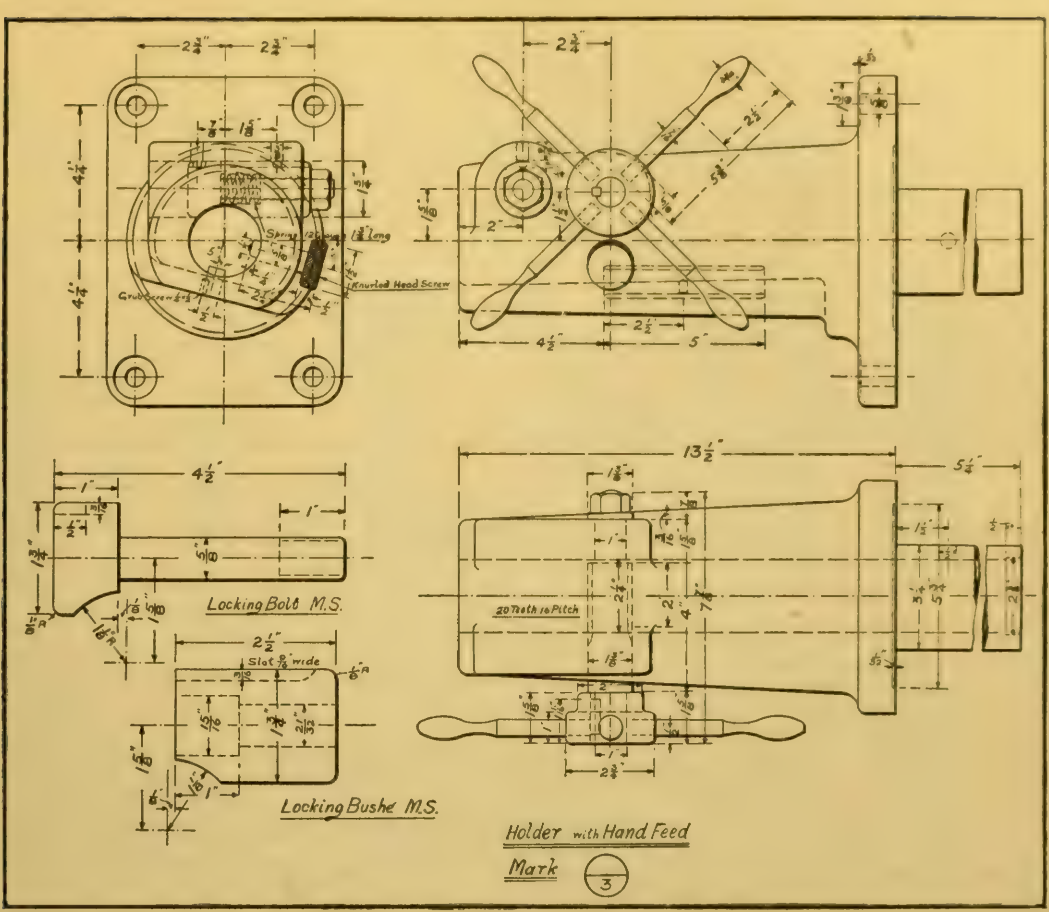


FIG. 2. SPECIAL HOLDER.

holder, and a rack-feed tool holder is illustrated in No. 7 Fig. 6. In addition to the rack feed there is a locking bolt in the holder to grip such tools as do not require the hand-feed motion, and there is also a knurled-headed pinching screw that is useful when setting tools. The centering tool for starting drills is of simple form with parallel shank to fit the adapting bush. This bush has a collar upon its fore end with a set screw to hold the drill in position when the bush is removed from the holder, and the shank of the bush is split so that the locking bolt clenches both the bush and drill when it is tightened up. Bushes of this type with various sized holes in them to take different tools are very useful, and could be arranged as a standard series fitting the various holders of all the turret lathes in the shop. In the set of tools under consideration no less than nine are actually used. The next operation is simply rough-drilling the hole with a straight fluted oil-supply drill carried in the same holder as the last. In this tool the method of making the oil-supply hole is worth noting, as it is simple to make and in the case of a stoppage from any cause is

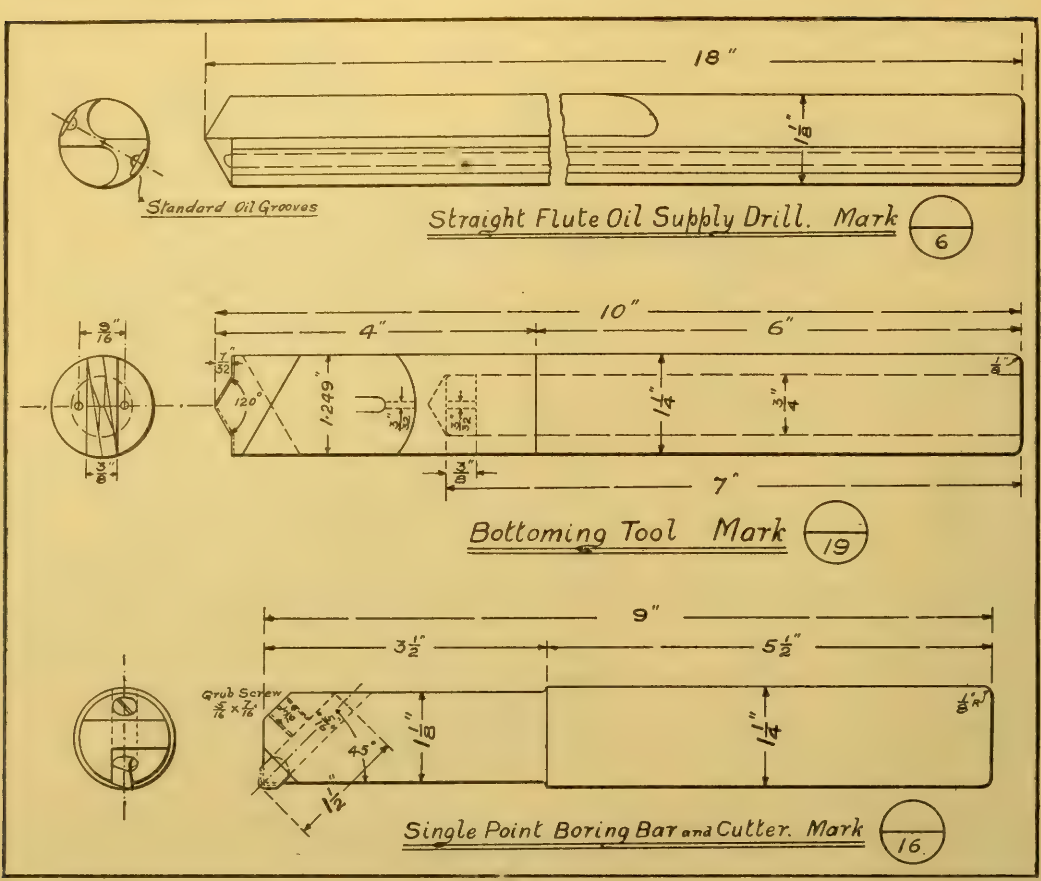


FIG. 3. STRAIGHT FLUTE OIL-SUPPLY DRILL (MARK 6).

easy to get at for clearing. The tool is shown in the uppermost drawing on the plate above—No. 6, Fig. 3.

After starting the large hole with a tool in the square turret a large flat oil-supply drill held in a 3-inch standard holder is used to rough out the large hole. The drill scarcely needs comment other than to draw attention to the oil arrangements and to the cutting lips which are quite radial. To bring the oil to the drill a plug is required to close the hole in the turret where the holder fits and direct the oil to the tool, otherwise as the turret is hollow it would be simply flooded with oil and there would be no pressure to convey the oil up to the tool. The roughing flat drill is shown on the opposite page, No. 10, Fig. 4.

When first a hole is produced by a drill from the solid or cored casting, there is no certainty that it will be perfectly concentric; in fact, it is likely to run off somewhat. To make it true a single point tool as No. 11, Fig. 5 is very good. This remark holds for both large and small holes except where the tool is strongly supported both back and front, that is to say, not overhanging as is the case here.

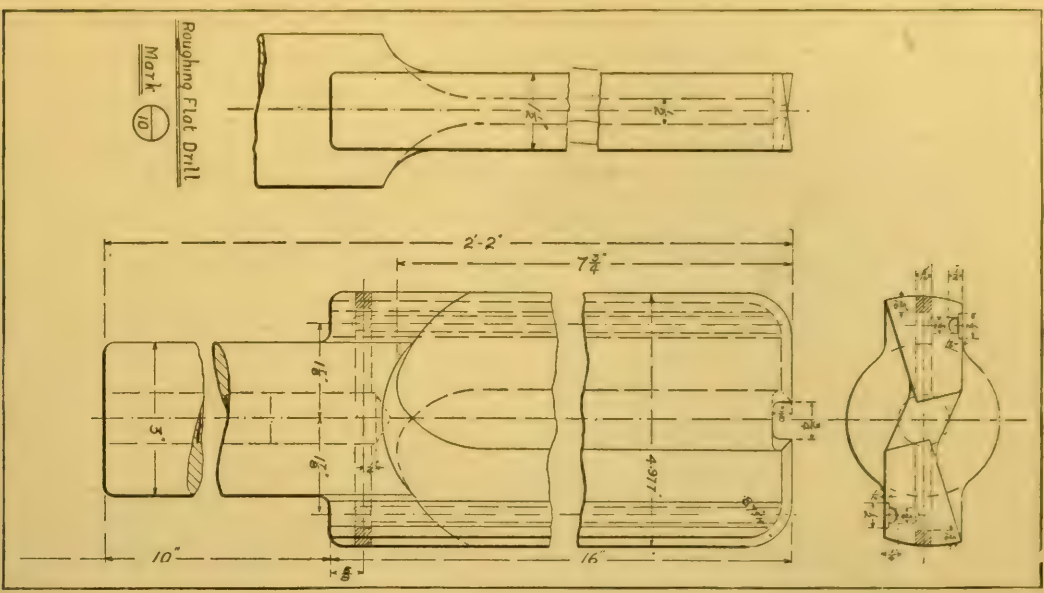


FIG. 4. ROUGHING FLAT DRILL.

Turning now to the tool No. 11 Fig. 5 to explain its points, the blades are separately made and are held in by set screws and there are adjusting screws to regulate the size of the hole. To prevent the cutting edge from pushing off when encountering a harder spot, hardened-steel steady pads are inserted at the back and bottom of the holder. To ensure the correct setting of the back cutter, it is fitted into a loose block which in turn is inserted into the holder, so that the tool can be taken out for grinding and readily be reset in position.

Let us turn now to the seventh operation, which consists of finishing the large hole with an adjustable oil-supply formed reamer carried in a special holder. That a reamer may make a hole its own size, on no account should it be rigidly held, for an exceedingly minute error of location in the turret may point the reamer out of centre an appreciable amount; consequently, the function of the reamer should be merely to size an existing hole, and to do that it must be presented to the hole and then be allowed to follow it. For this purpose the reamer is held in a floating holder—that is to say, one that will admit of a movement of the reamer in either lateral direction. The holder is bored out 1/32-inch larger than the shank of the reamer, and there is a similar difference between the retaining pin of the holder and the hole in the reamer shank. This amount of play or freedom would allow the reamer end to drop out of centre; so to present it truly to the hole, two adjustable spring plugs are inserted in the holder to take the weight, without disturbing the floating essential.

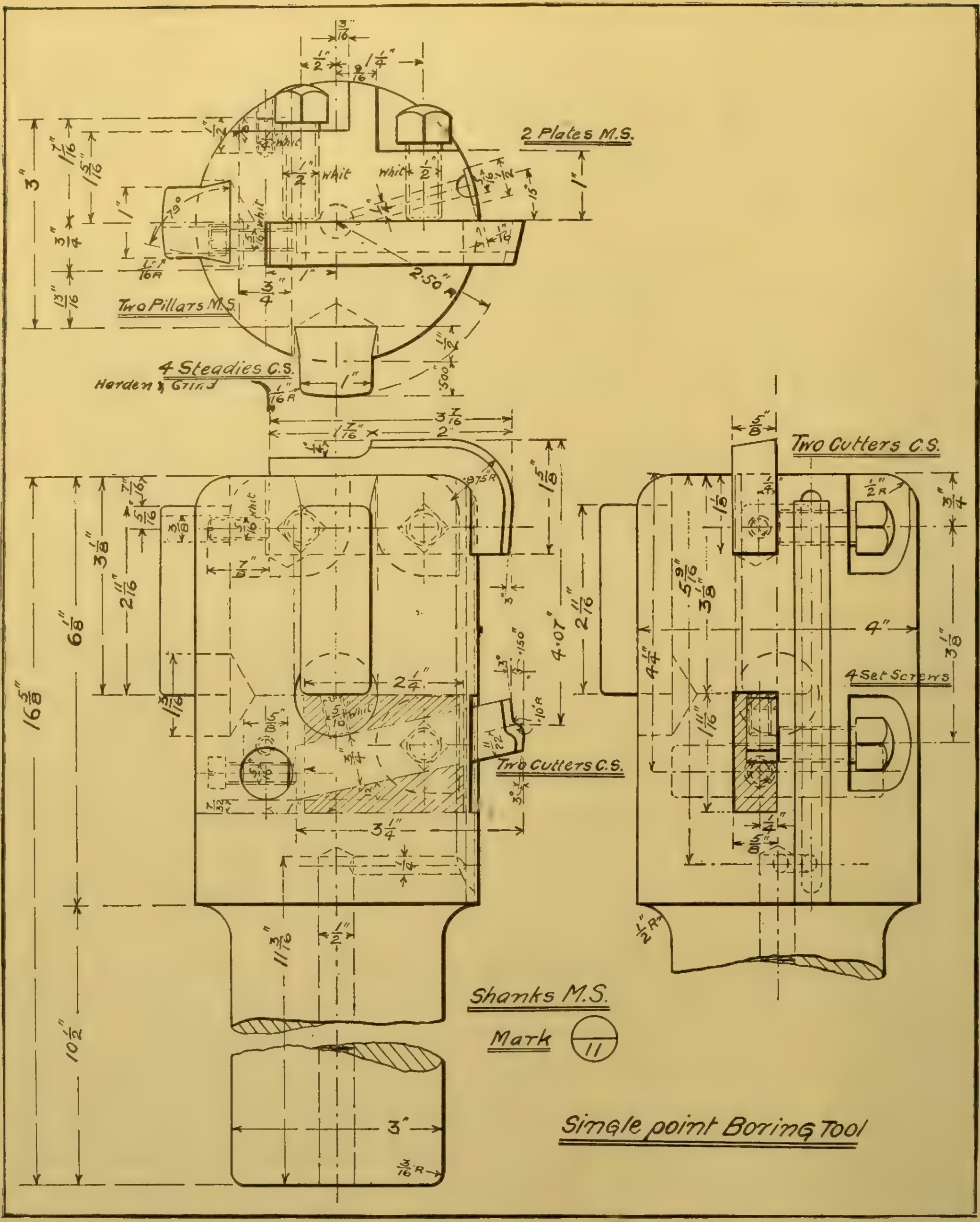


FIG. 5. SINGLE-POINT BORING TOOL.

Oil must be supplied to the reamer, for which purpose the shank is drilled, and to prevent the free escape of the oil past the shank where it fits loosely into the holder, a U leather of the same type as used in hydraulic machinery is provided as a packing. This will serve the purpose without detracting from the "floating" of the reamer.

The small hole now has to be finished, and as it is quite possible that it drew out of centre somewhat when first drilling, it must be trued up with a single-point boring tool, eighth operation. This tool is perforce somewhat slender, and to be effective must be held as stiffly as possible; so a special holder that will reach right up to the job is necessary. This holder is constructed like an ordinary standard one with the difference that is out of standard in its dimensions. As the same holder will be required to carry several other tools for the small hole, an adjustable collar is used on the shank of the boring tool to set it to the right distance in the holder when replacing it.

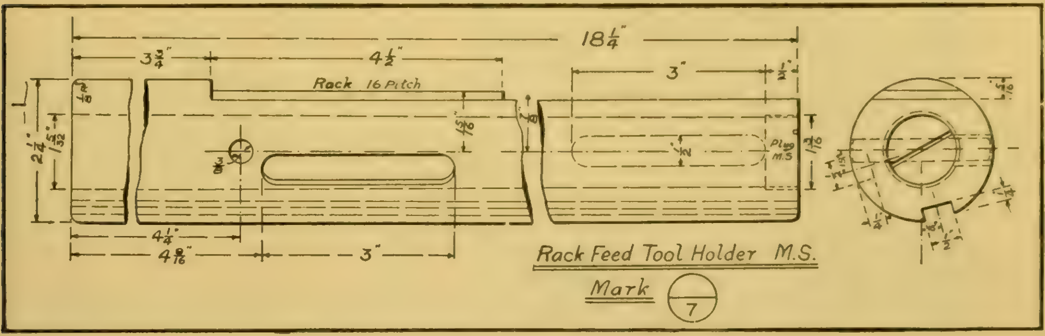


FIG. 6. RACK-FEED TOOL HOLDER.

If the small hole had drawn out of centre as anticipated by the use of the last tool, the centre left by the roughing drill at the bottom of the hole will be eccentric with the trued hole, so the ninth operation is to recentre and bottom the hole with the oil-supplying bottoming tool carried in the same holder as the last tool and set to distance with a similar collar. But, now, a supply from the pump needs to be conveyed to this and other subsequent tools that will be carried in the same holder, and as they must be frequently changed, the means for conveying the oil requires to be somewhat different from that usually provided. Obviously as the holder has a large cavity, which by the usual method of oil supply would become fully charged with oil, considerable inconvenience would result by the copious discharge of oil each time a tool is changed and the delay in refilling the cavity. To prevent this a special plug and pipe is placed up the interior of the holder. A good centre now having been formed at the bottom of the hole, the next drill (No. 21, Fig. 7) with oil supply, is inserted in the same holder to rough out the taper part where the firing pin comes. The tool is then changed for the self-steadying taper oil supply D bit (No. 22, Fig. 7) to perform the eleventh operation, which rough reams the taper hole, the depth being set in the same way as the previous tools.

The final sizing of the small hole and the tapered portion is done by a combination reamer (No. 23, Fig. 7) carried in the rack-feed holder (Fig. 6) held in the special holder. This reamer must be carefully fed in by hand to avoid breakage, hence the use of this holder. To facilitate construction the reamer is in two parts, a false nose being fitted to the main portion by a Morse taper. The shoulder between the large and small holder is now radiused with tool held in holder and set to distance with a collar.

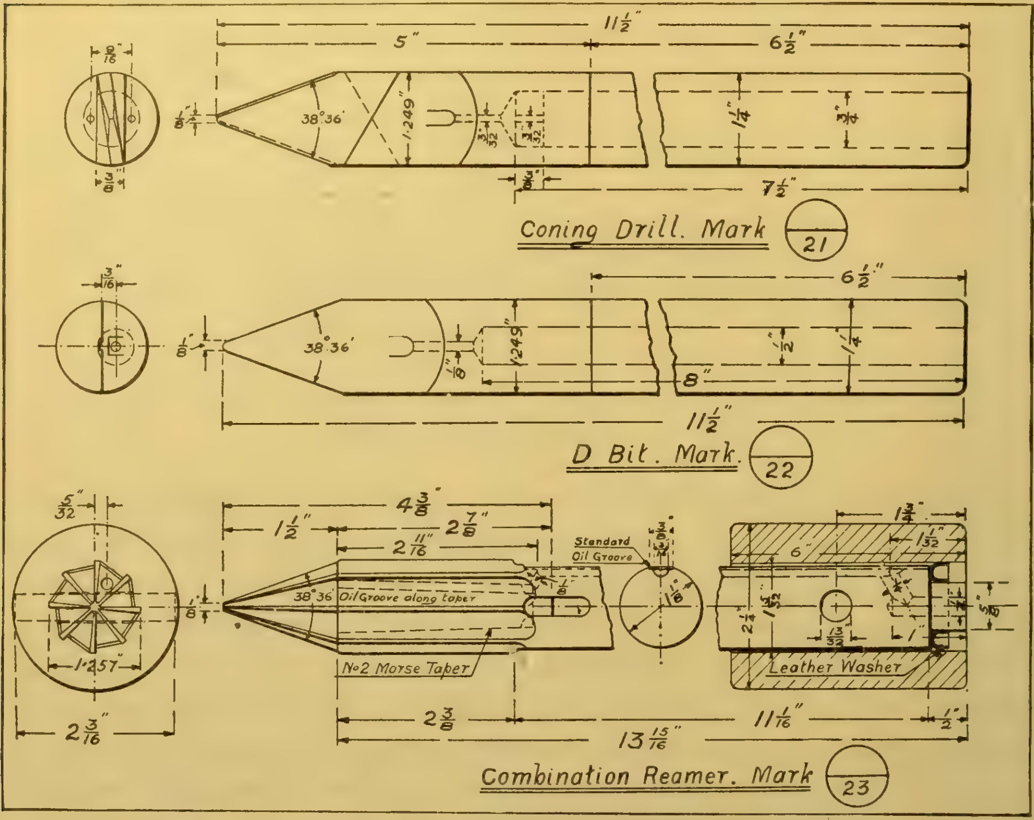


FIG. 7. CONING DRILL, D BIT, AND COMBINATION REAMER.

The fourteenth operation consists in recessing a groove in the small hole at the junction with the taper part, and this calls for the use of a special oil-supply recessing tool (No. 26, Fig. 8) held in a 3-inch standard holder. The groove has to be over ⅛ inch deep and is situated at the bottom of a hole 1¼ inches in diameter at a distance approximately 2 feet away from the face of the turret. To produce such a groove with a long overhanging tool held by a turret that has no traverse motion does not at first sight seem a simple job, yet the tool tackles the work in a very easy manner. The cutting tool itself is held in a spindle that may be rotated through half a revolution by a worm gearing. This spindle is eccentrically supported throughout its length by a fixed sleeve, the eccentricity being a half of the tool movement required, so that as the spindle revolves the cutting point follows the curve of an eccentric circle feeding gradually into its cut. This tool

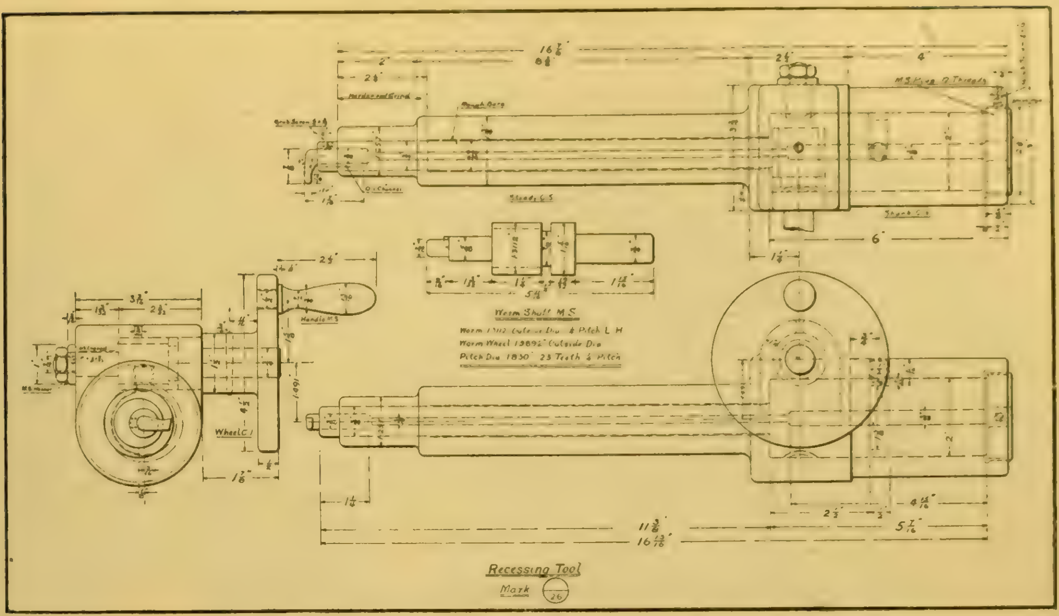


FIG. 8. SPECIAL OIL-SUPPLY RECESSING TOOL.

unless well supported will probably dig in and break, on account of the springiness due to so long an overhang. It is therefore supported by making the fixed sleeve fit the small hole reamed in the twelfth operation.

Oil passes through the spindle and along a groove beside the cutting tool which causes it to impinge upon the cutting edge. It will be observed with all these tools that particular attention has been concentrated upon the supply of oil to the cutting tools as nearly as it is possible to get it to the actual cutting edge; this is necessary, as the steel to be cut is so hard that the tools would quickly give out were this important point omitted.

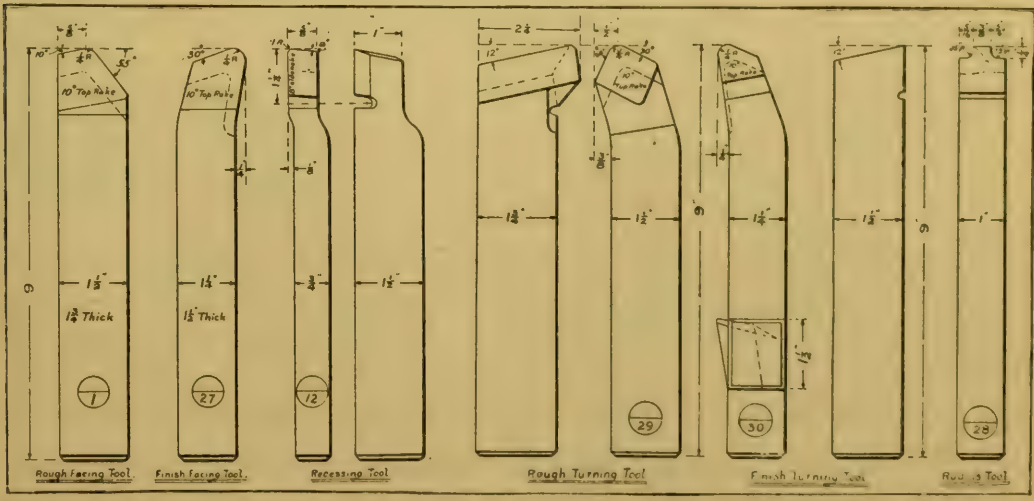


FIG. 9. TOOLS FOR TURNING OUTSIDE FACE AND FLANGE AND FORMING RADIUS ON CORNERS (NOS. 27 AND 28).

Before the first series of operations are finished, the outside face and flange require to be turned and the corners radiused, which is done as the fifteen and sixteenth operations with tools 27 and 28, Fig. 9, held in the square turret. The breech block having been bored and turned so far as is possible at the first setting, now undergoes the second series of operations. As but a very small portion of the outer diameter could be turned at the first setting, there is not sufficient finished surface to grip in the soft jaws of a self-centring chuck. That such a method of holding would be satisfactory is doubtful, even if it were possible in this case; therefore without question it is the right thing to hold the block upon an expanding drawback arbor for the further operation of turning, screwing, etc. Such an arbor with nose piece, etc., is illustrated in Fig. 10. A cast-iron nose piece A fits upon the spindle end, socketing upon the flange to keep it concentric. Fitting this nose piece there is a cast steel hardened and ground bush D with a shouldered portion projecting one and a half inches in front of the nose piece. This bush is keyed in position so that it revolves with the cast-iron portion, and as it is accurately fitted, the projecting part receives the large hole of the breech block. Within the bush the mild-steel plug B with coned end is free to slide but may not rotate, as there is a preventing feather key, and upon the coned end there is the expanding bush C which expands as the coned plug is drawn towards the nose piece by a bolt through the hollow spindle of the lathe.

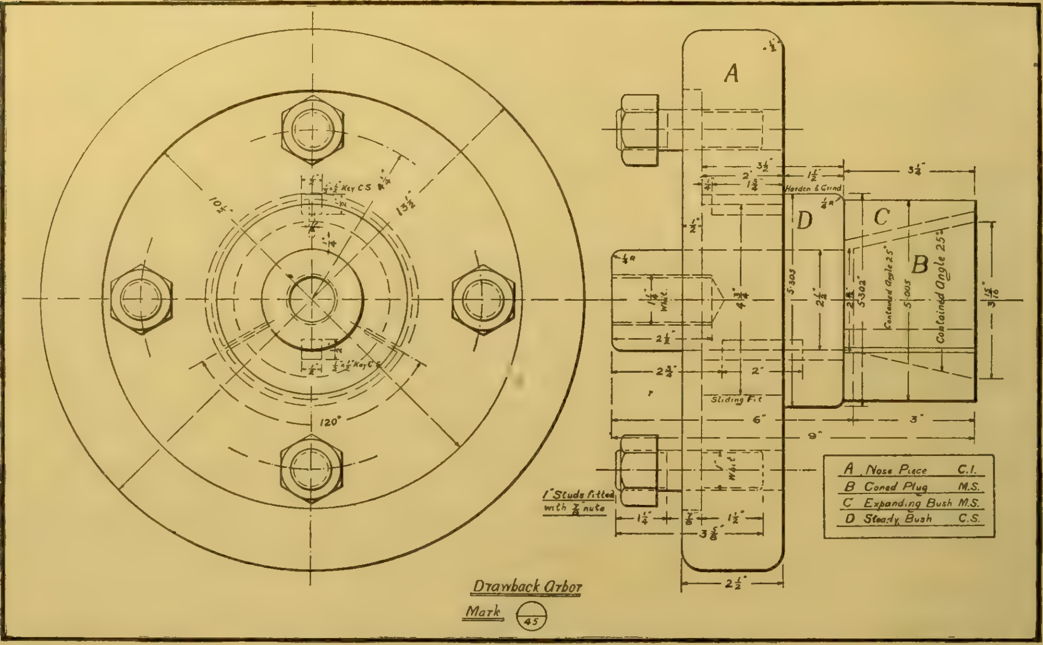
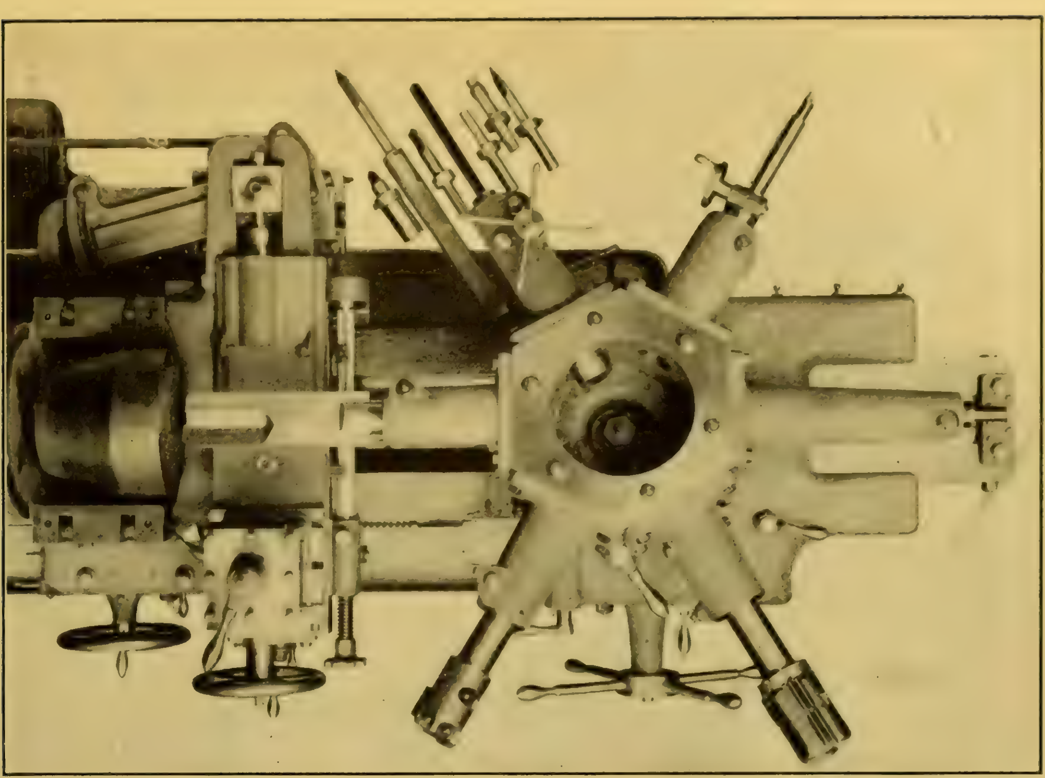
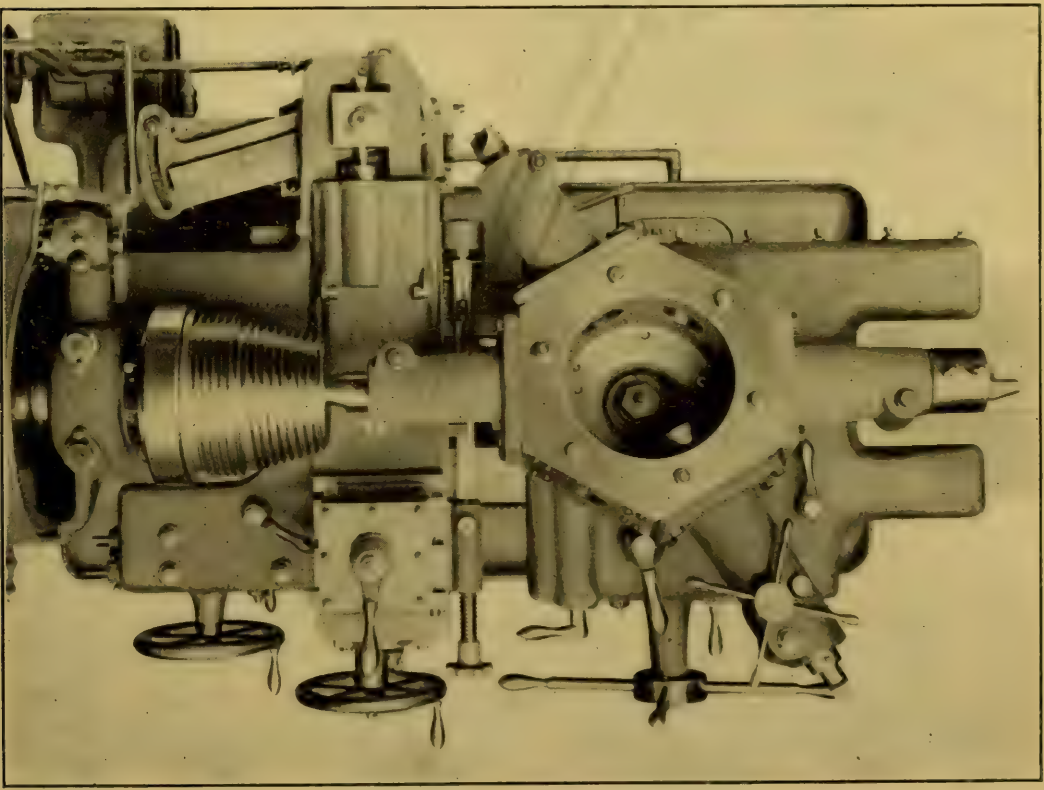


FIG. 10. EXPANDING DRAWBACK ARBOR.





FIGS. 11 AND 12. ILLUSTRATIONS OF THE TURRET AND TOOLS SET FOR USE ON BREECH BLOCK OF 6-INCH QUICK-FIRING GUN.

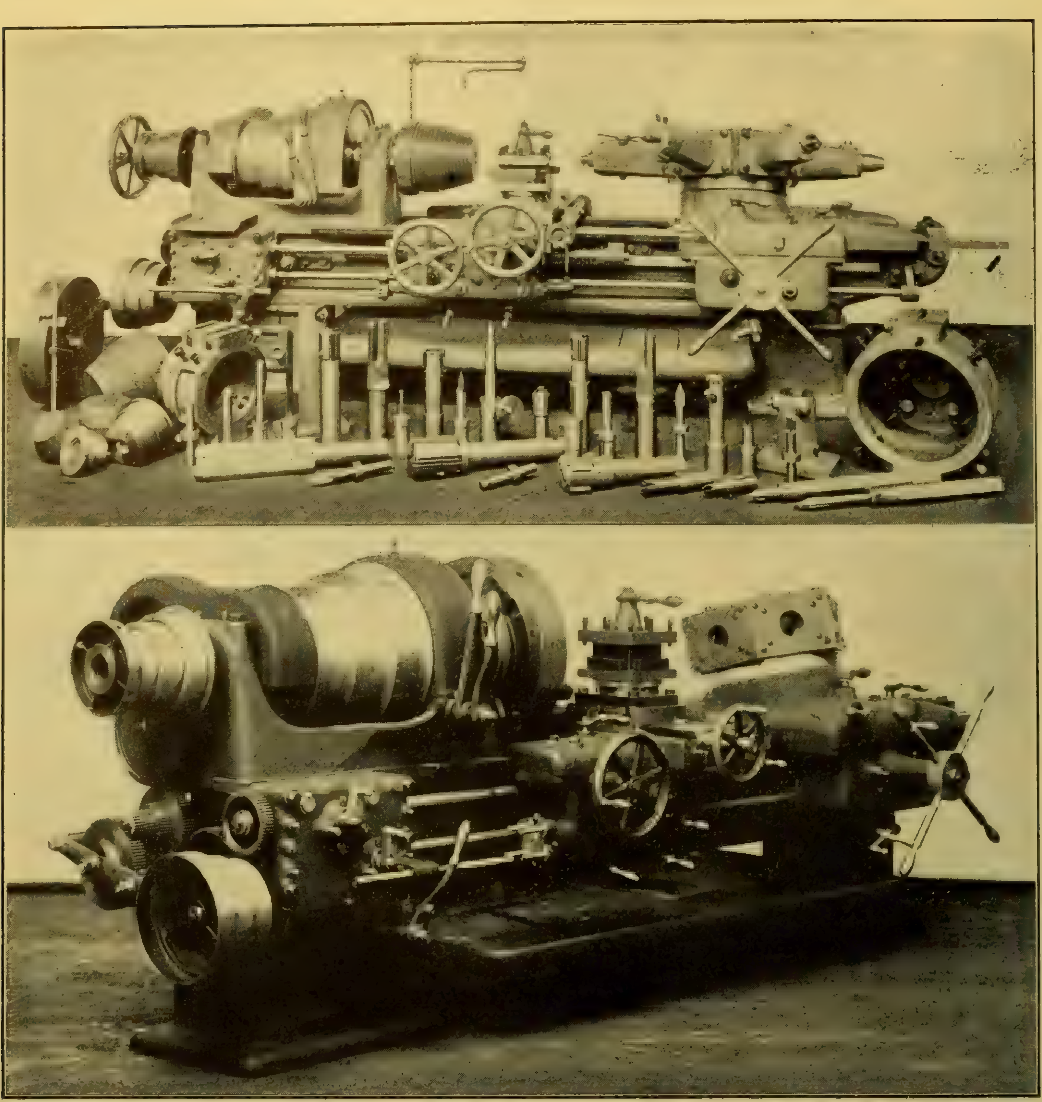


FIG. 13. HEXAGON TURRET LATHE BY MESSRS. ALFRED HERBERT, LTD., COVENTRY, ENGLAND.

After facing the block with the same tool as was used for the first operation it is centered, and the counter-bore is drilled with a tapered flat drill carried by one of the 3-inch standard holders. This type of tool holder is very simple and comparatively cheap to make, so it can frequently be used in turret-lathe work. When the counter-bore has been finished with tool 33 Fig. 14, the remainder of the work in this series of operations has to be done from the square turret.

The third series of operations are all done with the breech block held on the same drawback arbor, and as they consist of a straightforward series with comparatively plain tools to finish, turn, and groove the block and cut the thread, using the taper slide upon the back of the lathe to form the correct taper where required, no further explanation is necessary. In this series of operations it is interesting

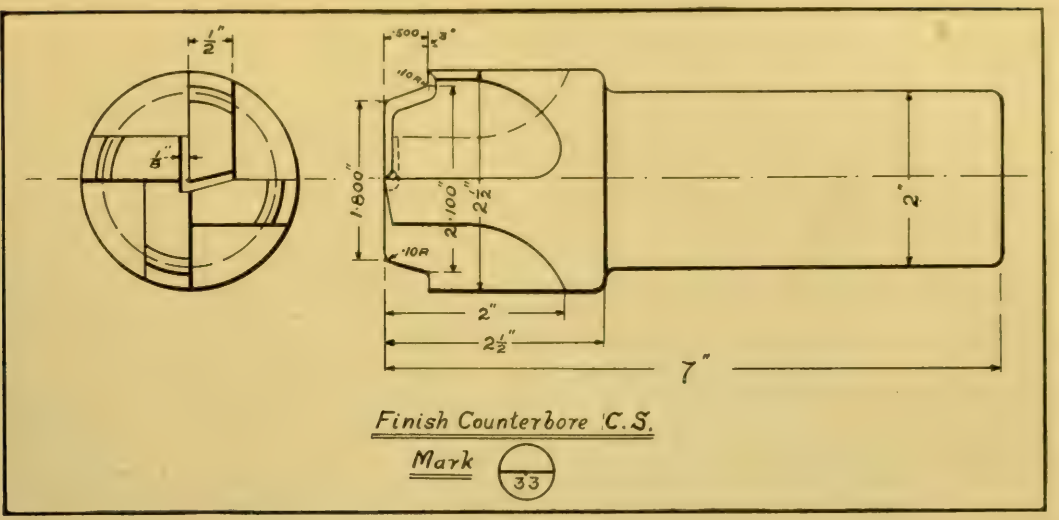


FIG. 14. FINISH COUNTER-BORE.

to note that as more tools are required that can be held in one square turret a second one is brought into service, the work of changing the turrets being quite small as compared with setting and resetting tools.

The last operation is the relieving of the taper thread, for which purpose a specially pitched leader screw, slightly longer in pitch, is brought into requisition. The screws of the breech blocks in question are made with a different pitch on the one side of the thread to that on the other to permit a certain amount of compression or "upsetting" when the gun is fired, the pitch variation being such as is practically found to result in a good bedded fit after firing. Were the thread made an exact fit at first, the compression would probably cause the front threads to take all the pressure after the first firing, with damage to the gun.

In these explanations, the numbering on the tools is in simple sequence for ease of reference in the illustrations and so not in accordance with a system of marking such as has been advocated for the successful location of the tools in stores.

The short space of this article admits of but touching the fringe of so important a subject as the Tooling of Machines, yet perhaps it will serve to show to what extent high-class tooling is being carried at the present day. The degree of accuracy obtainable and the low cost of production can only be realised by those who have successfully followed through such methods of working.

The arrangement of these tools will be better understood by reference to the illustrations on page 793, which are from photographs of the machine with tools set ready for use.

THE MANUFACTURE OF IRON BY ELECTRO-METALLURGICAL PROCESSES.

By Adolphe Minet.

THE metallurgy of iron has attained such a degree of perfection, and makes use of such powerful facilities in the greatness of the capital and equipment involved in it, and in the quantity and variety of the products *, that it seems difficult to grapple with its problems or to realize an economy upon its methods. They can however be attacked from at least one point of view—that of the *cheapest production of the heat-units* necessary both for the reactions and for the power to drive the machinery of the plants for the production and working of the metal.

If some form of carbon is used as reducing agent, the ordinary metallurgists demand further from that element the heat and the power which they want, while the electro-metallurgists make use of natural forces (generally water power) for heat and power, attaining an economy of carbon of about 80 per cent., in the case, for instance, of converting ore into iron or steel. In other words, where the ordinary metallurgists consume two tons of carbon to produce a ton of steel, starting from the ore, the electro-metallurgists use only 400 kilogrammes.

In order to show that the new methods offer an advantage over the old ones, it will be proper, in the first place, to make a comparison in each particular case between the saving attained in the coal and the expenses involved in the installation of natural power (including conduits, turbines, dynamos and electrical connections), its depreciation and maintenance. I say "in each particular case," because the problem cannot be treated in a general manner, by reason of the variation of the price of coal according to the industrial centers considered, as well as of the cost of hydraulic installations; not to mention other very important factors such as the ore and the reagents, of which the price delivered at the works is essentially variable. I shall not concern myself here with the price of the raw materials which enter into the metallurgy of iron—a price which is known, or anyhow is easily ascertainable; but I think the reader would be interested by the presentation of some data on the cost of electric heat units, according to the most recent hydraulic installations.

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* The annual production, in the whole world, is 30,000,000 tons of pig iron and steel; it consumes 60,000,000 tons of mineral fuels, out of the 600,000,000 which are mined every year.

Hydraulic Power and Electric Heat Units[*].—The useful electric heat units, that is to say, the heat units developed in the electric furnace itself by the current, are expressed in practice in three different units: (1) in large calories or kilogramme-calories; (2) in kilowatt hours, and (3) in horse-power hours. To simplify comparisons, I shall make use of a single unit, the kilowatt-hour. The values of the others are as follows:

1,000 large calories = 1.16 kilowatt hours = 1.58 horse-power hours.
1 kilowatt hour = 864 calories = 1.36 horse-power hour.
1 horse-power hour = 635 calories = 0.736 kilowatt hours.

In the large hydraulic installations in Europe—3,000 to 10,000 horsepower for example—and with the head varying from 50 to 200 metres or more, the price of a horse-power year, depreciation and maintenance included, ranges between 30 and 70 francs. This refers to the useful horse-power year within the furnaces, that is to say, the electric horse power at the electrodes. I shall adopt the average price, 50 francs. As the effective running is generally 350 days per year and 23 hours per day, say, 8,000 hours, a simple calculation will give for the respective cost of the three units in use: Horse-power hour, 0.63 centimes; kilowatt hour, 0.86 centimes; 1,000 large calories, 1 centime.

With these figures we shall be able to follow readily the descriptions which the electro-metallurgists give us, and to appreciate whether any saving takes place in their processes.

Metallurgy of Iron.—The metallurgy of iron includes three principal phases: (1) preliminary operations; (2) metallurgy proper; (3) working of the metal. We shall see that in each of these parts electricity can be used to advantage.

1. Preliminary Operations.—Leaving out of account native iron, which is met only very rarely, and meteoric iron, the ores of iron

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[*] Let E be the electromotive force of the current, or the difference of potential at the electrodes (entrance and exit), expressed in volts; I the intensity of the current in amperes; $g = 9.81$ the acceleration of gravity; 75 the mechanical equivalent of the horse-power second; 425 the mechanical equivalent of heat. The useful power, or useful energy of the current, per second, is expressed:—

In watts: $W = EI$; 1 kilowatt (1,000 watts) equals 102 kilogrammeters.

In kilogrammetres: $Q_k = \frac{EI}{9.81}$; 1 kilogrammetre equals 9.81 watts.

In horse power: $H. P. = \frac{EI}{9.81 \times 75} = \frac{EI}{736}$; 1 metric horse power equals 736 watts.

In large calories: $Q_c = \frac{EI}{9.81 \times 425} = \frac{EI}{4169}$; 1 large calorie equals 4,169 watts.

The useful energy *per hour* is represented by quantities 3,600 times as large.

occur under the following forms: Red hematites, Fe_2O_3; magnetic iron, Fe_3O_4; brown hematites, $Fe_2O_2(HO_2)$; iron pyrites, FeS_2, employed only after having been used in the manufacture of sulphuric acid; spathic iron, $FeCO_3$; and vivianite, $Fe_2(PO_4)_2$, which has little importance for the industry with which we are concerned. Before undergoing metallurgical treatment the ores are submitted to one or several preliminary operations, according to their nature:

(a) Mechanical working, consisting of a simple coarse crushing of the lumps of ore which are too large, and of a washing to remove the sand and clay which occur mixed with the ore. Here hydraulic installations offer every advantage—cheap power and water at will.

(b) Roasting, for the purpose of transforming spathic iron or magnetic iron, for example, into the more readily reducible peroxide. Here again the electric calories furnished by natural power are more economical than the calories set free by the combustion of coal.

(c) Magnetic preparation, for ores containing iron or the magnetic oxide of iron; here again the advantages are all in the use of water power for putting in movement the apparatus of separation and producing the powerful magnetic fields.

2. Metallurgy Proper.—The methods of treatment of the ores for obtaining the metal, cast iron or steel, may be divided into two main classes: (1) the direct method, or method furnishing the metal in a single operation, by direct treatment of the ore; by this method the cast iron, wrought iron and steel are obtained extra soft; (2) the indirect method, or method of two parts—conversion of the cast metal, cementation of the wrought iron and cast metal. The accompanying table of these different methods shows for each one of them the state and the nature of the products, as well as their method of operation.

Direct methods.	Pasty metal.	Iron; steely iron.	Catalan forge.		
	Liquid metal.	Cast iron.	Blast furnace.		
Indirect methods.	Solid metal.	Cementation steel.	Decarburation of cast iron.		
			Carburation of wrought iron.		
	Pasty metal.	Wrought iron.	Conversion of cast iron.	"Feu Comtois."	
				Low hearth.	
				Puddling.	
	Liquid metal.	Steel.	Simple Fusion; Crucible.		
			Conversion of cast iron. (Converters.)	Bessemer.	
				Thomas and Gilchrist.	
				Robert.	
			By reactions.	Martin. Siemens.	Acid.
					Basic.
					Neutral.
				Perrot, with removable and rotary furnace.	

I shall preserve this classification for distinguishing the electro-metallurgical methods; but I may say at once that except as far as the cementation processes are concerned, which in view of their principle necessarily proceed by the indirect method, electro-metallurgists have every interest in adopting in other cases the direct method, with which they obtain at will, in the same apparatus, all grades of cast irons, wrought irons and steels.

3. Working of the Metal.—Without entering into details of this phase of the metallurgy of iron, it can be seen that a great saving will be attained by the use of natural forces to set in motion the powerful machinery necessary for this work. In this also, electricity can perform important services; among other things, several processes of electric welding are known and have received the sanction of good practice.

Electro-metallurgy of Iron.—It can be said in a general way that electro-chemical methods differ from the processes of ordinary metallurgy, either in the arrangement of apparatus, or in the mode of operation; and that, as compared with these latter, they have the advantage of utilizing one of the characteristic properties of electricity—the *power of accumulating in a very restricted space a very large quantity of energy.* If it is borne in mind that by reason of this accumulation of energy the losses are reduced to a minimum, and that by making use of natural forces the calorific energy necessary for the reactions is obtained at the lowest price, it will perhaps be deemed interesting to follow the evolution of the new methods and to know their actual status. They are divided, as metallurgical methods, into two classes: (1) direct methods, and (2) indirect methods.

Direct Methods; Stassano Processes.—Mr. Stassano has invented two types of apparatus for the electro-metallurgy of steel by direct method, that is to say, starting from the ore, and without passing through casting.

First type: The first of these arrangements, to which Mr. Stassano gives the name of electric blast furnace * is represented in Figure 1. It is arranged for heating the reaction chamber by the electric arc. The first trials carried through by that engineer gave so much hope from the start that it was possible to form a company immediately, and to install in the valley of Camonica, in the Bergamese Alps (Upper Italy) three electric blast furnaces of 500 horse power each, with a view to the treatment of the iron ore of the country, and with a total annual production of 4,000 tons.

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* English patent. No. 11,604, 1898.

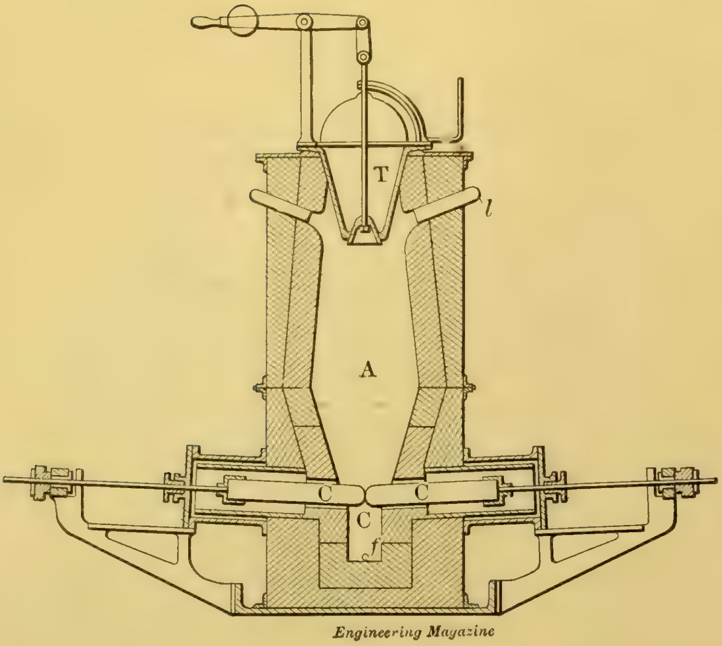


FIG. I. ELECTRIC BLAST FURNACE, STASSANO SYSTEM.

The ore, prepared as described below, is charged into the shaft, A, by means of the hopper, T; it is melted by the electric arc burning between the electrodes, C C; from the crucible, C, the iron and the slag run out at f. The ores—oxides or carbonates—are first pulverized and subjected to an electro-magnetic preparation for increasing their contents of iron; the carbonates are completely calcined. The quantity of carbon necessary for the reduction, as well as the quantity of fluxes to be added for the scorification of the gangue contained in the ore, are calculated according to the analysis. The quantities of carbon, lime and silica thus determined are pulverized and mixed with the enriched ore. After having added also about 5 to 10 per cent. of tar as an adhesive, the mass is subjected to a pressure of 200 to 300 atmospheres, and, thus bound together, it is broken into fragments which are then

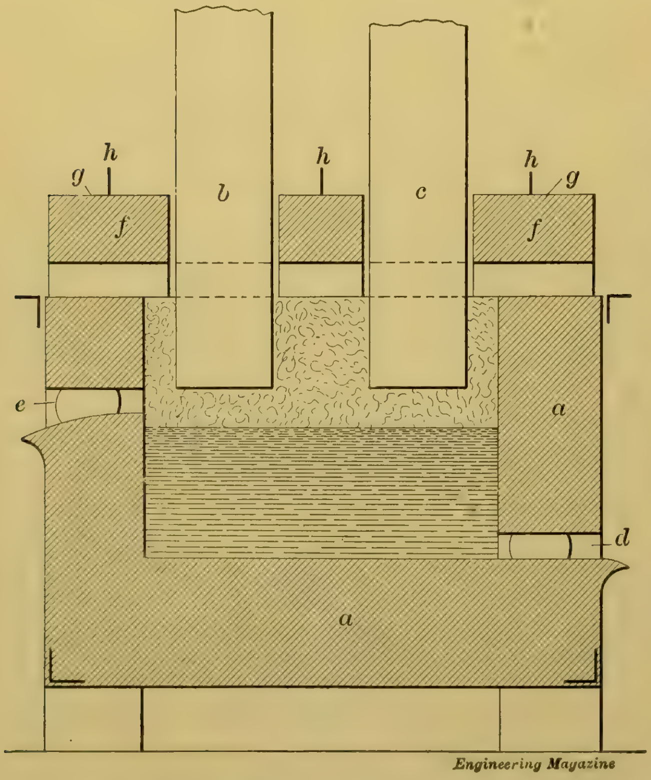
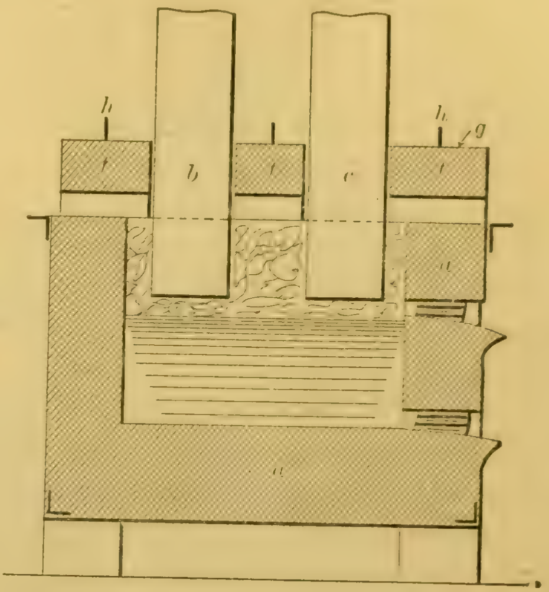


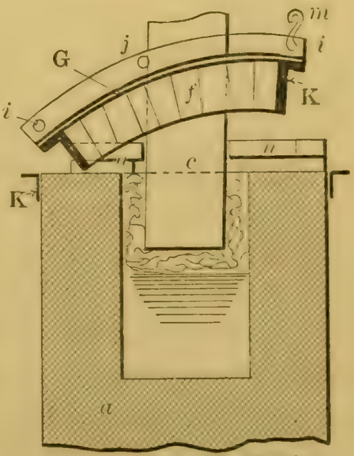
FIG. 2. HÉROULT FURNACE, TYPE I.

charged into the blast furnaces. At the temperature which rules in the chamber where the electric arc is burning, the sesquioxide of iron is reduced by the carbon mixed with the ore; and the metal resulting from this reduction, and containing more or less carbon, collects in the crucible. The foreign elements pass into the slag, which can be let out by a special opening.

According to Mr. Stassano, it is possible with powerful furnaces to succeed in producing a ton of steel at a cost of 3,100 horse-power hours (or their equivalents, 2,282 kilowatt hours, 1,969 thousands of calories), costing 19.69 francs, and replacing 1,500 kilogrammes of coal at 29 francs a ton, say, 45 francs. By the fact of using electric calories, a first saving is attained of 25 francs per ton of steel produced.

Frages-Héroult Processes.—Héroult, to whom we are indebted already for several applications of electro-metallurgical industry, was one of the first to study the electro-metallurgy of iron, and he established several types of electric furnaces, which are being exploited in France and in Sweden.





Engineering Magazine

FIG. 3. VARIATION OF HÉROULT FURNACE, TYPE I, AND

FIG. 4. TRANSVERSE SECTION OF HÉROULT FURNACE, TYPE I.

First type*: The first apparatus applied on a large scale to the electro-metallurgy of iron by Héroult dates from 1900. The characteristic of this method is the fact that one can obtain at will all varieties of cast iron, wrought iron and steel, of all states of carburation, in the same apparatus, and if one wishes, in the course of the same operation. Figure 2 shows a vertical longitudinal section of this furnace. Figure 3 shows a variation from it, in which the two outlet holes are upon the same face of the crucible. Figure 4 exhibits the crucible open for charging (transverse vertical section). The furnace consists in its essential parts of a crucible, *a,* in which the electrodes, *b, c,* dip; it is provided with two outlet holes at different levels; the lower one, *d,* serves for the outlet of the metal; the other is designed for the evacuation of the slag. The metal to be worked is kept sheltered from the carbon of the electrodes.

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* French patent, No. 305,317. Société Electro-Métallurgique de Frages.

For the direct production of the metal, starting from the ore, the crucible is charged in the ordinary way, by casting into the bottom a little of a mixture of ore and carbon in suitable proportions. Under the action of the current the ore melts and is reduced; the heavier metal collects at the bottom, while the slag accumulates above. As soon as the slag becomes obstructive, it is run off by the upper outlet hole, either continuously or intermittently. According to the proportions of carbon and the temperature, one can obtain at will soft iron in the pasty state, or a metal more or less carburated. This apparatus is equally suitable for indirect methods. For example, for the treatment of cast iron and of scrap.

Second type *: The second apparatus, called *electric furnace with fluid electrode,* is designed in such a manner as to treat ores previously melted or pasty, or sufficiently softened to descend progressively in the shaft of the furnace in which the reaction takes place. The shaft, with refractory lining inside, contains a column of coke of convenient height, or of any other fuel which is a good conductor of electricity, through which passes an electric current, and with which mixes the melted or pasty ore introduced from an adjacent preparatory furnace, which also acts by electricity. The fuel, by which the passage of the current for the reduction of the ore takes place, constitutes in reality one of the electrodes; it flows in the furnace continuously, in proportion as the operation proceeds.

Héroult has invented two variations of the same type. Figure 5 is the section of a furnace which is especially suitable for the production of cast iron, wrought iron, ferro-silicon, ferro-manganese and other similar products. A carbon crucible, B, is surmounted by a refractory masonry, C, which is designed to contain the active part of the column of carbon, and also the slag. The crucible, B, is pierced by an outlet hole, D, for the melted metal, and the stack or jacket, C, has a hole, E, for the slag. The latter may occupy a quite different

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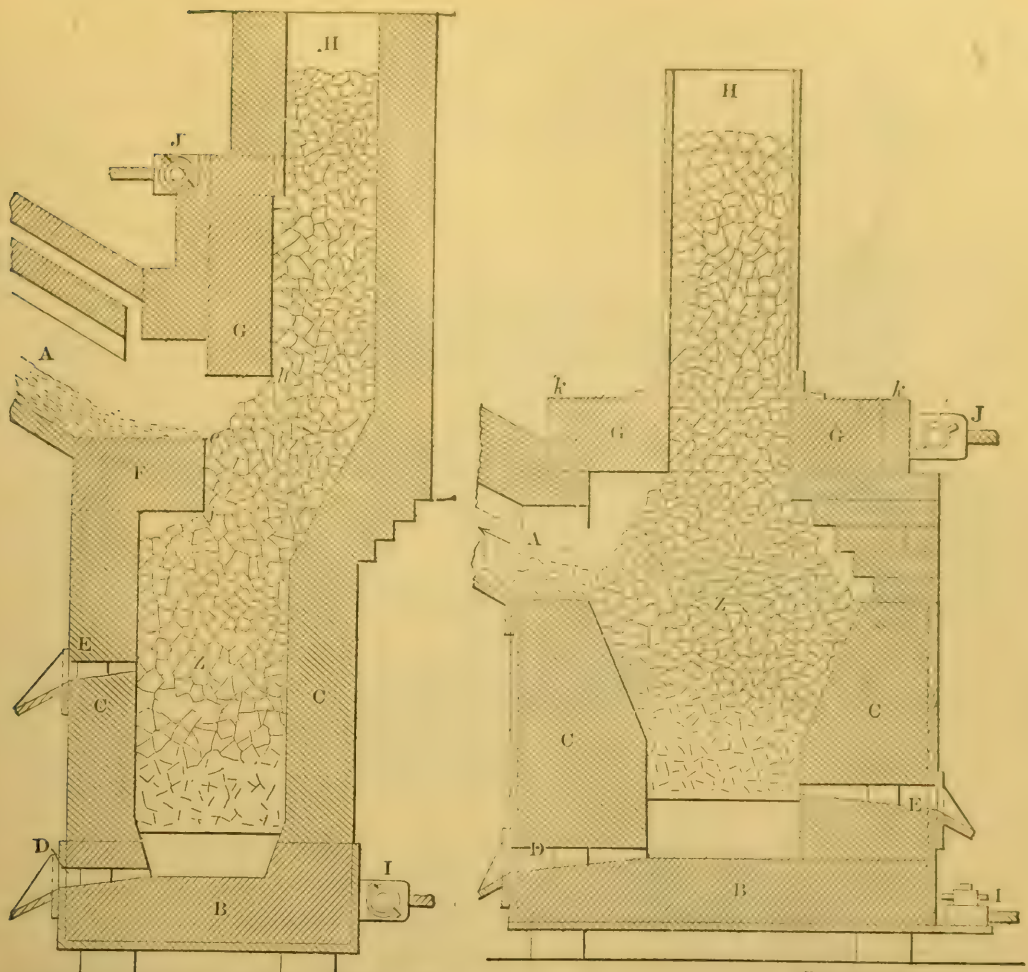
* French patent No. 318,638. Société Electro-Métallurgique Française de Frages.



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FIGS. 5 AND 6. ELECTRIC FURNACE WITH FLUID ELECTRODE, AND VARIATION OF THE TYPE.

point of the periphery of the trough. The terminals from the source of electricity are connected on the one hand to the crucible B at I, and on the other hand at J to the block G, against which the fuel rubs in flowing or descending in the stack. Figure 6 represents a variation in which the crucible, C, is preferably of carbon, and the column of coke, Z, makes contact on the one hand with the carbon crucible, B, and on the other hand with an upper conducter, G, of carbon. In both cases the hot gases proceeding from the reaction escape in the adjacent preparatory furnace.

Harmet Process.—Figure 7 gives the set of apparatus invented by M. Harmet for the purpose of making cast iron, wrought iron, or steel directly from the ore. This set includes three principal parts, each one corresponding to one phase of the treatment; a first apparatus in A, for the fusion of the ores; a second one in B for the reduction; and a third one in C for the further treatment of the metal. It is the regulator of the Martin electric furnace. The two first ones, A and B, are continuous in running and production. The third, C, is continuous in its operation, but it is tapped repeatedly, allowing the accumulation of the metal produced so as to give a large quantity at once.

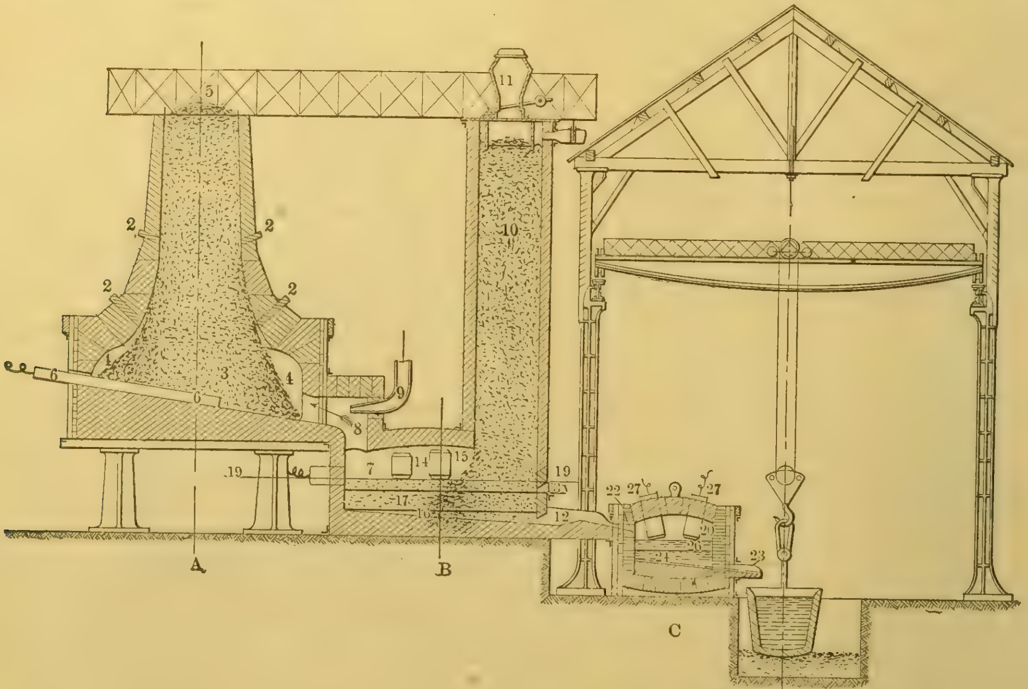

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FIG. 7. GENERAL VIEW OF HARMET APPARATUS.

The regulator represented in the set of three apparatus is also reproduced in detail in the three following figures; Figure 8 is a section through the entrance channel from the reducing apparatus and the outlet hole. Figure 9 is a plan.

M. Harmet has made a comparison, from the point of view of economy, between his process and those actually used for the manufacture of steel, assuming that the coke costs 25 francs per ton, and the coal the same, and that 1,000 electric calories cost 1 centime. In the triple furnace he counts upon producing one ton of steel, finished, with 3,200 horse-power hours (which are equal to 2,344 kilowatt hours, or 2,025 thousands of calories), which involves an expense of 20.21 francs per ton of steel produced. These are substantially the same figures as those of Stassano, and the economy attained by the use of electric calories, as compared with the use of steel, would here also be 25 francs per ton.

Keller Process.—We have again a case of the direct production of steel; the whole system, which calls to mind the Harmet process as to its general arrangement, consists of two furnaces arranged in series.

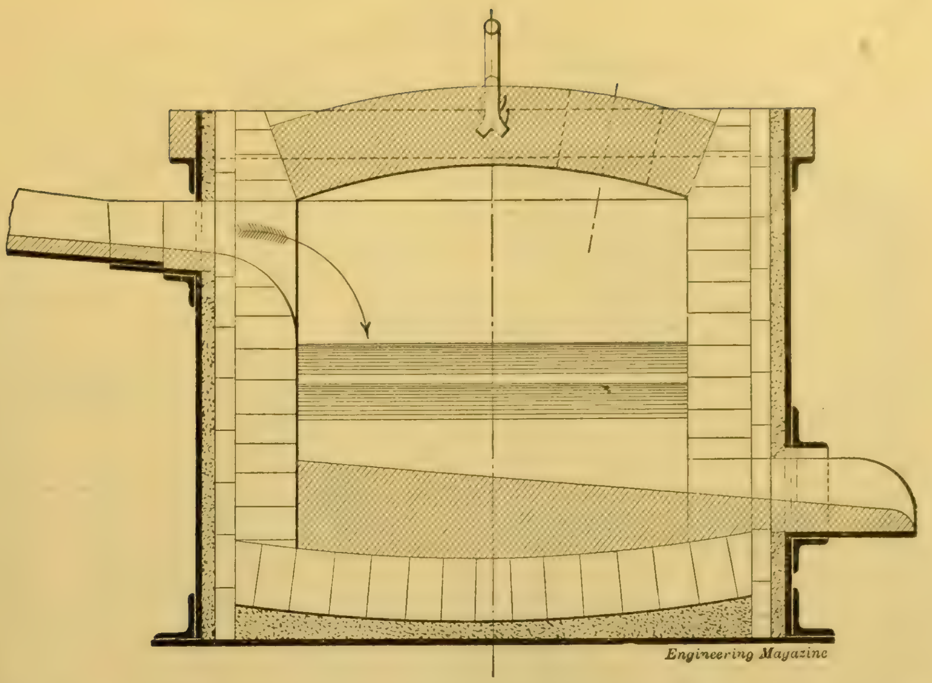

FIG. 8. SECTION OF HARMET REGULATOR THROUGH THE ENTRANCE CHANNEL AND THE OUTLET.

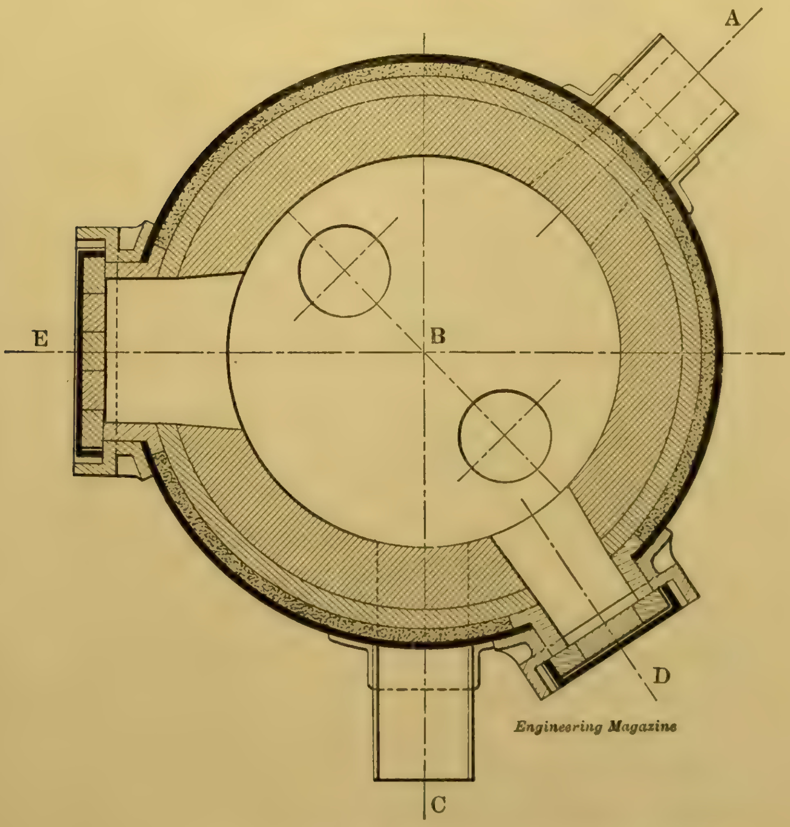

FIG. 9. PLAN OF HARMET REGULATOR.

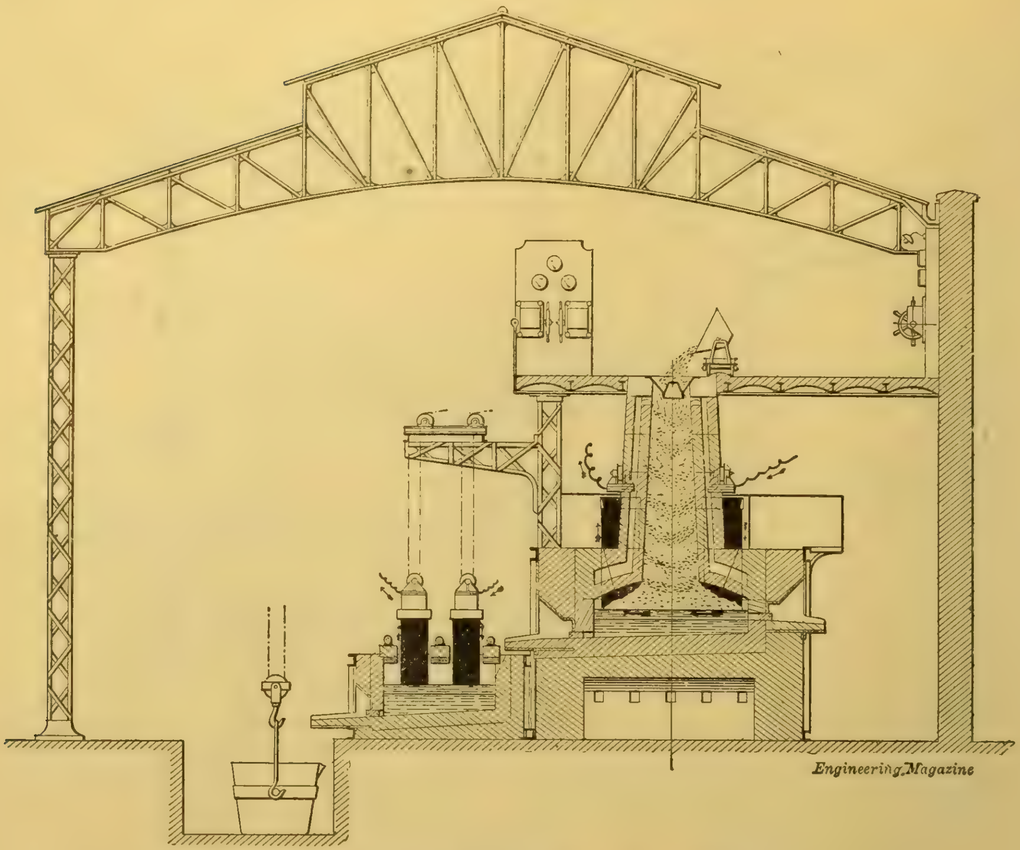

FIG. 10. KELLER ELECTRIC BLAST FURNACE.

The upper furnace (Figure 10) contains two groups of two vertical electrodes each, the two electrodes of the same group being connected in parallel, and the two groups in series. These four electrodes are placed in the same vessel with refractory walls. The body of the furnace is inclined towards the outlet hole. It is constructed in the same manner as the body of the Martin furnace. Under the outlet hole of the upper furnace the conversion furnace is set up. This latter consists of a movable refractory vessel, which serves simply as a receptacle for the molten metal. This receptacle is closed by refractory covers, which can be removed, and within it two vertical electrodes can be raised or lowered by means of a lifting mechanism controlled by hand. The furnace is closed in the manner usual in blast furnaces.

As soon as the upper furnace is started running the materials are introduced through the furnace top, and fill the furnace. The reduction of the metal and the fusion of the ore begin to take place only in the body of the furnace. After some time of running the carbon monoxide and the ore are sufficiently hot to react. From that time on the reaction takes place not only in the lower part of the furnace, but also in the region of fusion. After some hours of running the raw metal is run out into the conversion furnace, which has been previously warmed and already contains melted matter. Soon afterwards the upper furnace is emptied of slag, by one of the special side taps.

M. Keller built an electric blast furnace at the Kerrousse works, near Hermebont (Morbihan). It produces a ton of steel with 3,800 horse-power hours (or their equivalents, 2,797 kilowatt hours, or 2,413 thousands of calories); that is to say, at a cost of 24.13 francs per ton of steel produced, thus attaining an advantage of 21 francs per ton, as compared with the use of coal as source of heat. It will be noticed that the figures given by MM. Stassano, Keller, and Harmet are in very good agreement.

Process of Chavarria Contardo.—This engineer has taken out a series of patents bearing upon the electro-metallurgy of iron. In the first patent he claims: (1) a continuous electric furnace, utilizing the whole of the heat produced by the voltaic arc, which is entirely surrounded by the raw materials treated, but without ever being touched by them; (2) a continuous electric furnace in which, independently of the heat produced by the electric arc, use is made also of the entire heat produced by the gases resulting from the chemical reactions, whose combustion in the interior of the furnace is brought about by the introduction of a gas tending to produce combustion; (3) in another furnace, the use of two different materials; ordinary refractory masonry, and material of extra refractoriness or cooled by the circulation of a fluid, in order to permit the furnace to support both the high temperatures produced electrically, and the chemical and mechanical actions due to the introduction of the air; (4) in a fourth class of furnaces special arrangements by means of which the electric arc can be sunk in the material to be treated, without ever coming in contact with it.

In a second patent * M. Chavarria Contardo describes a reverberatory furnace, for continuous operation, heated by electricity.

The third patent † describes: (1) a method of preserving the electrodes outside of the furnace; (2) the possibility of introducing the current at a fixed point, the electrodes moving backwards and forwards as needed, under the action of a regulator controlled by an independent current (3) the complete utilization of the electrodes, without their depreciation.

The fourth patent ‡ describes a continuous electric furnace with closed front, itself supplying its own current through utilizing the

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* French patent No. 197,777, March 2, 1900.

† French patent No. 197,777, March 2, 1900.

‡ French patent No. 299,490, April 20, 1900.

gases set free in the reactions, by means of a gas engine driving direct or alternating-current dynamos.

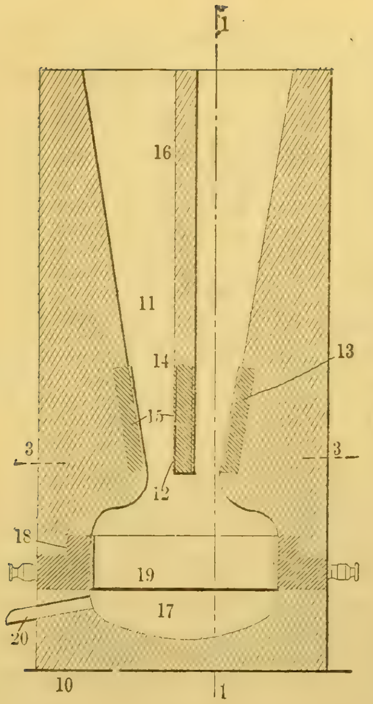

FIG. 11. CONLEY FURNACE.

Conley Furnace.—This is a resistance furnace, arranged for producing the steel by the direct method. The mixture of ore and carbon is melted and brought into contact with resistances raised to a very high temperature by the passage of an electric current. The furnace inside is constructed in the form of an inverted cone. The crucible which terminates it at the bottom is very large. It has about the same diameter as the largest section of the cone (Figure 11). In the narrow place formed at the point of the inverted cone the wall is made of plates of high electrical resistance. The cone is divided into two perpendicularly by a wall, which in the narrow part also ends in plates of poorly conducting materials. These plates are made of a mixture of clay or refractory earth with retort carbon or graphite. The crucible is surrounded horizontally by a belt formed of a certain number of plates. The rest of the furnace is constructed of refractory brick. The ore, to which carbon has been added, is introduced and melts when it comes into contact with the resistance in the lower part of the furnace, above the crucible. The metal and the slag run into the latter, where they are maintained liquid. The metal can be treated in the crucible as in an ordinary furnace; in short, it can be transformed into steel.

To produce 100 tons of steel in ingots by the Conley process would require the consumption of 5,000 horse-power days, or 120,000 horse-power hours of electrical energy; that is to say, the consumption for the production of one ton would be 1,200 horse-power hours, or their equal, 843 kilowatt hours, or 762 thousands of calories. These figures are much lower than any of those given before; and, pending more definite information, I question their correctness. I think that in the present state of affairs one must assume an expenditure of 3,000 to 3,500 horse-power hours to produce a ton of steel by the direct method.

Adolphe Minet's Furnace.—I have proposed a furnace system *

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* French patent. Adolphe Minet, December 2, 1899.

* German patent, Minet-Neuberger, 1901.

for the purpose of economically applying electro-metallurgical processes in works that are distant from any natural power, but that use cheap sources of heat, such as low-grade gas, gas from blast furnaces, etc.

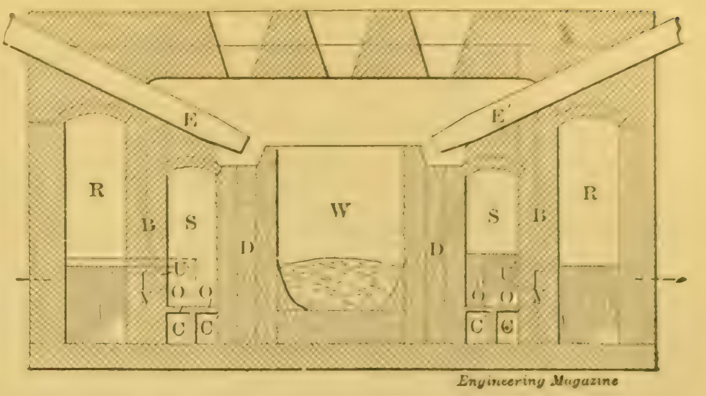

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FIG. 12. LONGITUDINAL SECTION OF MINET FURNACE.

The furnace depends upon the separate or simultaneous utilization of three sources of heat, according to the temperature of the reaction: blast-furnace gases, either in combustion or not in combustion; poor or rich gases coming from gas works; and electricity in the form of current passing through the materials treated, or in the form of the electric arc. In connection with gas engines driven by the gas from blast furnaces and furnishing the motive power for dynamos, it ensures in iron works, for example, the application of most electro-metallurgical processes under conditions of economy of the same order as those attained in works driven by natural power.

The furnace consists of a central chamber, W (Figures 12 and 13, longitudinal vertical section and longitudinal horizontal section), supplied with an outlet hole, T, and separated from the heating chambers, SSSS, by partitions, DDD, of which the nature varies according to the reactions and the products of the reactions. The heating chambers SS receive through the holes OO either blast-furnace gases from the flues CC or rich or poor gases from the flues C'C' coming from a gas producer or gas works; and these gases burn in the chambers SS. These chambers are separated from other

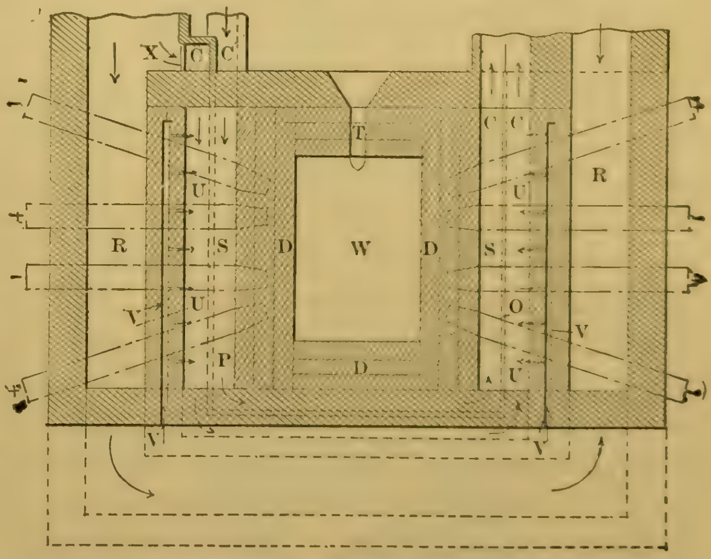

FIG. 13. HORIZONTAL SECTION, MINET-NEUBURGER FURNACE.

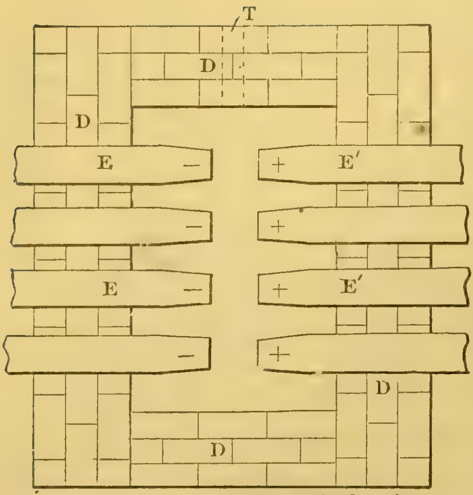

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FIG. 14. ELECTRODES OF MINET-NEUBURGER FURNACE.

reheating chambers RR by partitions BB, of refractory clay, in which are built flues U opening into the combustion chambers SS by air holes, V. The reheating chambers RR are traversed by the blast-furnace gases, of which a part enters into the flues CC, which are provided with a regulator X, for controlling the quantity of gas which should pass into these flues. This part burns in SS; the greater part of the blast-furnace gas passes unburned from RR and is used for supplying the gas engines. The electric current is conducted by the electrodes EEE′E′, which in the various cases take the positions represented (Figures 13 and 14). It is possible also to conduct the blast-furnace gases to the center of the reaction at VV, and to take advantage of their reducing properties or to burn them directly above the raw materials.

With a furnace of this kind it is possible to obtain every temperature from 200 degrees to 900 degrees (centigrade) by using the blast-furnace gases alone in combustion or not in combustion; from 900 degrees to 1,300 degrees by using the blast-furnace gas with other rich or poor gases; and from 1,300 degrees to the temperature of the arc, by adding to these different sources of heat the action of the electric current.

Ruthenburg Furnace.—The *Iron Age* published a short time ago some data regarding this apparatus, which can be used for two purposes. It may serve simply for the agglomeration and concentration of ores of iron, or also for the reduction of ores.

It consists (Figure 15) of a horizontal magnet in the form of a horse shoe, mounted upon a support, about which it can turn. The magnet is fastened upon the support by means of a hinge, and this hinge is insulated. The cylinders BB′ can be brought near to one another or separated by means of a screw placed behind them, of which the points of attachment are insulated. The pole pieces, which are of cast steel, have the form represented in the section, and produce an intense magnetic field. The cylinders, concentric with the branches of the magnet, turn in bronze blocks. These blocks are covered with a coating of carbon, forming electrodes, and are water-cooled.

As already said, the apparatus can fulfil two functions: The agglomeration of iron ore, if carbon is not added to the ore; or also the partial reduction of the ore, if carbon is added. The charge is introduced automatically upon the upper part of the cylinders, and the magnet holds it in contact with them while they turn. An arc is formed at the place where they are nearest together. At that point the charge is rendered incandescent, and the reaction takes place.

Most of the arrangements described under the present heading can serve equally well for the preparation of the metal by the indirect method.

Indirect Methods; Process of Hillaíret and Garnier.—* The process of Hillairet and Garnier forms an experiment rather than a real application. These engineers wished to prove that it was possible to produce easily by the use of electricity as calorific agent, a cement steel of a definite degree of hardness. In a refractory tube are placed end to end a stick of carbon and a rod of iron containing 0.1 per cent. of carbon, in such manner that the ends in contact are about the middle of the tube. The whole is heated in a little blast furnace. During the heating a suitable continuous current is passed through the two rods, from the carbon to the iron. At the end of three hours the iron rod is withdrawn suddenly from the tube, and cooled by immersion in water. The end of the iron rod which was in contact with the stick of

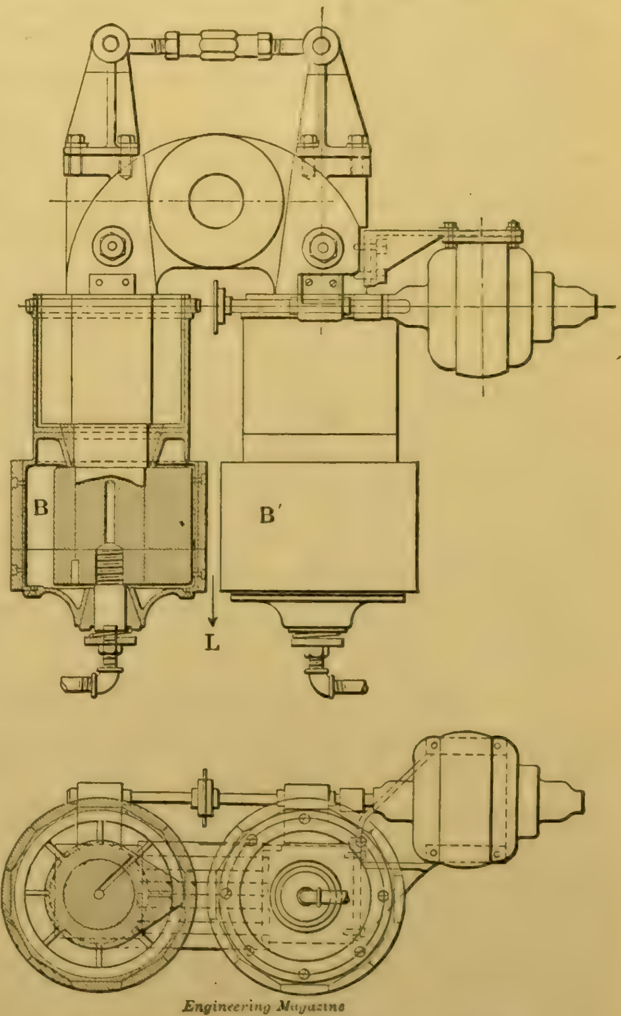

FIG. 15. FURNACE OF RUTHENBERG, OF PHILADELPHIA.

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* Nernst-Borchers, *Jahrbuch für Elektrochemie für* 1894. Halle 1895; *Engineering and Mining Journal* (New York), v. 57, P. 57, 1894.

carbon is hardened to a depth of ten millimeters to such an extent that it scratches glass.

By reversing the current in another experiment it is proved that the cementation is due to the transfer of carbon into the iron by the action of the current. In this case the iron rod, through which the current now enters, remains almost unchanged.

Laval Process.—The author of this process has proposed the replacement of the blast-furnace method by a process of electric fusion.

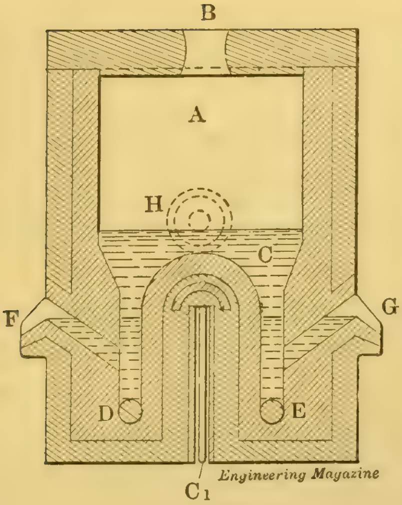

FIG. 16. LAVAL FURNACE.

He recommends,* in the first place, roasting the ores of iron, with the ordinary fluxes, to reduce them, without letting them reach the point of fusion. The fusion is effected afterwards in a furnace represented in Figure 16. The working is separated into two compartments by a bridge C, supplied with cooling arrangement C′. In these two compartments two electrodes D and E are arranged; by the opening B, a molten bath (fluxes and magnetic iron) is let in upon starting the current. The resistance of the bath should be so great that the heat developed by the passage of the current maintains fusion. To prevent the bath from decomposing by electrolysis, an alternating current is used. The metal, introduced into the furnace by the opening B, descends to the bottom of the bath, is melted there, and collects in the two polar compartments until it attains a sufficient height to run out by G or F. The bath or the slag is maintained at the same height by the tube H. The cooling apparatus consists of a hollow, flat metallic body provided with two openings, by which the refrigerant enters and leaves.

The author does not make any statement as to the nature of the metal produced, whether it is cast iron or steel. It is to be observed, besides, that his apparatus is a furnace for fusion rather than for reactions; and that, unless in applying the cheaply produced electricity also to the reactions, the Laval process does not seem to offer any important advantage over the ordinary metallurgical methods.

Gérard-Lecuyer's Process.—The process of Gérard-Lecuyer dates from 1895; it depends, like the method of the Bessemer converter, upon the transformation of cast iron into steel by oxidation; but while in the Bessemer process the quantity of air introduced at each instant into the interior of a large mass of molten cast iron is very small, in the process of Gérard-Lecuyer, on the contrary, it is the quantity of molten cast iron which is in the minority; it is introduced, in a finely divided state, into the presence of a considerable amount of air, so that the oxidation of the cast iron can take place instantaneously. The nature and the fineness of the steel obtained in this manner would be governed by varying the fineness of division of the metal, or the duration of contact of the globules of molten cast iron with the air. The raw cast iron is turned directly from the cupola into the upper receptacle, from which it flows in the incandescent state and with a definite velocity across two electrodes, between which an arc is burning. The great heat of the arc raises the molten cast iron at the moment of its outflow to such a temperature that the mere exposure of the globules to the air (Figure 17), or the mere blowing of the air into the metal (Figure 18), are sufficient to eliminate the oxidizable bodies contained in the cast iron.

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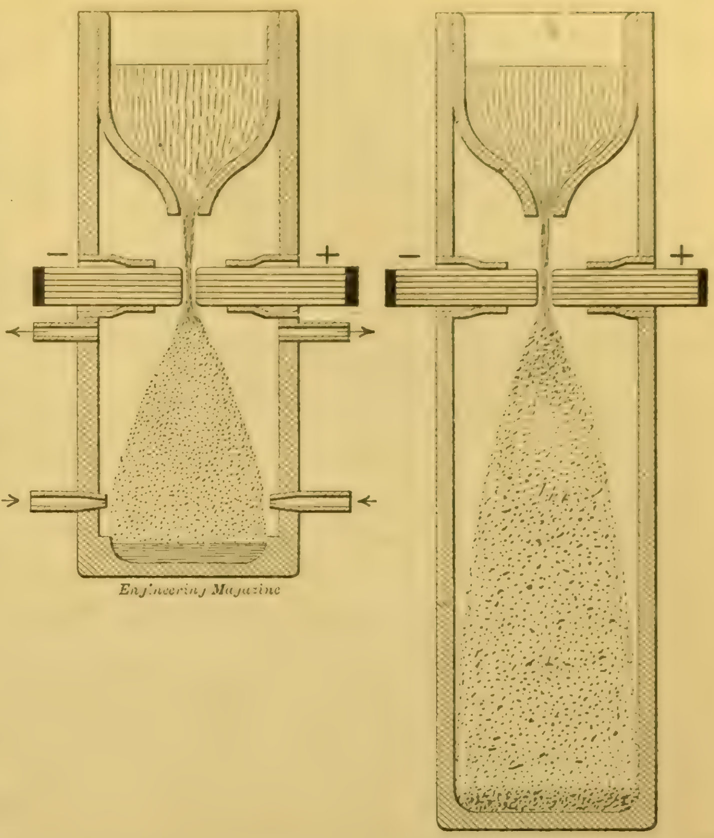
* *Engineering and Mining Journal*, v. 57, p. 509, 1894.



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FIGS. 17 AND 18. GÉRARD-LÉCUYER FURNACE, TYPE 1 (ON THE RIGHT) AND TYPE 2 (ON THE LEFT).

Some of the numerical results obtained in practice are as follows: 5 kilogrammes of melted cast iron take 55 seconds to flow past the electrodes; the constants of the current being 30 volts and 800 amperes, the corresponding consumption of energy is 0.48 horse-power hours. Thus 10.4 kilogrammes of cast iron are converted per electric horse-power hour consumed; or one ton per 100 horse-power hours, approximately. It must be mentioned that these figures do not include

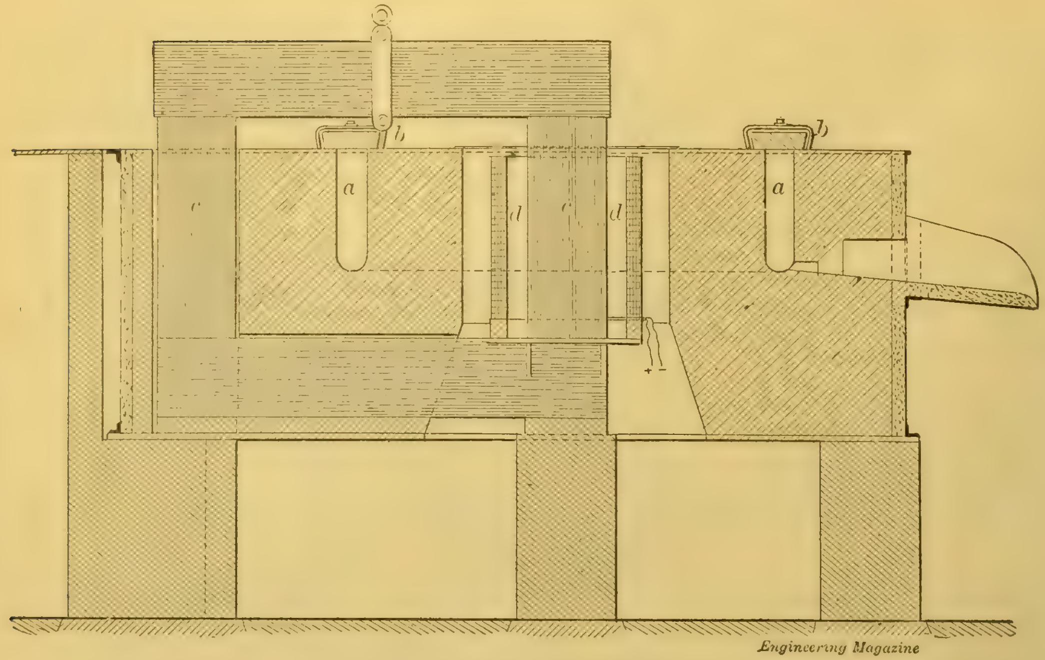

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FIG. 19. KJELLIN FURNACE.

the expenditure of energy for melting the cast iron, nor for reheating and melting the steel produced.

M. Gérard-Lecuyer was to have made some changes in this first arrangement, the nature of which I am not able to state.

Kjellin Furnace.—Designed for the production of steel from cast iron. It has the peculiarity of operating without electrodes (1).

A ring, *aa* (Figure 19), of which the sides and the bottom are made of refractory brick, forms the chamber of the furnace, which is closed by the plates, *bb*. At the center of the furnace is placed a core, *c*, made of steel plates insulated from each other. This core is surrounded by a coil, *dd,* of insulated wire, and is continued from the other side of the ring, forming a rectangle. The terminals of the coil, *dd,* are connected to the terminals of an alternating-current dynamo. When the current passes through the coil, an alternating magnetic flux is produced in the core; this flux induces an alternating current in the ring formed by the metal contained in the furnace. The ring having but one turn about the core, the current induced in it is nearly equal to the current from the dynamo multiplied by the number of turns of wire of the coil, *dd.*

Some interesting experiments were made upon this furnace, * by varying its dimensions, in the course of the year 1900. The first furnace consumed 78 kilowatts, and produced 270 kilogrammes of steel

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*** Furnaces without electrodes date from a few years ago. Besides that of Kjellin, there are the furnaces of Schneider, of E. A. Colby, and of Ferranti.**

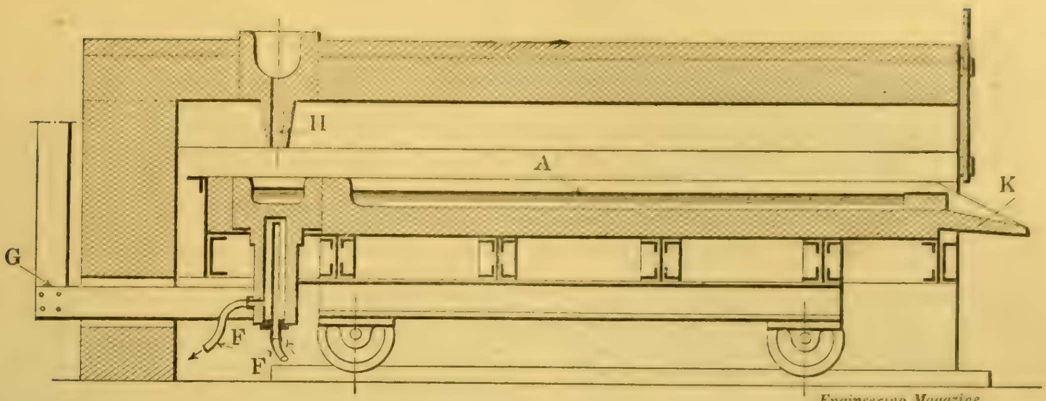

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FIG. 20. LONGITUDINAL SECTION OF GIN FURNACE.

in 24 hours; a second furnace reached a production of 600 to 700 kilogrammes in the same amount of time. Finally, a third apparatus, absorbing 330 kilowatts of power, gave one ton of steel at an expenditure of 828 horse-power hours, or their equivalents, 609 kilowatt hours, or 526 thousands of calories. These are nearly the same numbers as those found by M. Gin, as we shall see later, in starting from molten cast iron at 1,300 degrees centigrade. In order to take into account the heat absorbed in melting the cast iron and in raising its temperature to 1,300 degrees, the above figures must be doubled; we have thus finally: 1,656 horse-power hours, 1,212 kilowatt hours, or 1,052 thousands of calories. The expenditure of energy in the indirect method would accordingly be only half of that necessary in the direct method; but in view of the cheapness of the energy, this constitutes an advantage of only 10 francs in favor of the former method. On

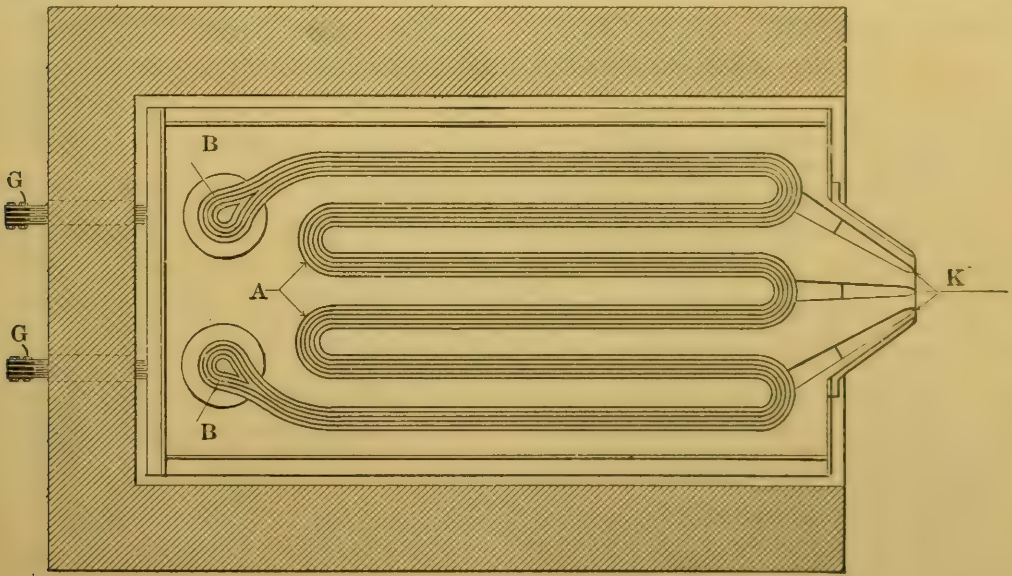

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FIG. 21. HORIZONTAL SECTION OF GIN FURNACE.

the other hand, the direct method has the benefit of the much greater difference between the cost of the ore which it uses and the cost of the cast iron which forms the raw material of the indirect method.

Gin's Furnace.—This furnace (Figures 20 and 21) comprises as its essential parts a canal of great length and small cross section, *A*, which is filled with melted cast iron, and of which the ends are connected to blocks of steel cooled by an interior current of water, F. The passage of an electric current of suitable intensity in the conductor consisting of the molten metal sets free a quantity of heat sufficient to maintain the whole mass in fusion, and to raise it to the temperature most favorable for the production of reactions of conversion. On the other hand the rather large cross section of the blocks, G, H, forming the ends of the circuit, prevents the passage of the current from producing there too high a temperature, which is further limited by water circulation.

For the conversion the method by dilution ("scrap process") may be applied by adding to the cast iron a calculated amount of scrap, which dissolves in the liquid bath. It is also easy to use the method of oxidation by the ore ("ore process"). The oxygen of the iron oxide added to the bath burns the silicon, manganese and carbon; the carbon is eliminated the more rapidly the higher the temperature.

With the ore process M. Gin obtains one ton of steel by consuming 567 kilowatt hours, the power used by the furnace being 300 kilowatts. With the scrap process, using double the above power (600 kilowatts), the electric energy necessary to produce one ton of steel would be 631 kilowatt hours. It will be noticed that the figures given by M. Gin are virtually the same as those given by M. Kjellin.

Conclusion.—As may be judged from the present study, the efforts made by electro-metallurgists have already been considerable, and their enterprise deserves to be taken into consideration seriously; they have also to their credit the easy and economical production of the whole series of alloys of iron or steel with silicon, manganese, chromium, tungsten, titanium, and nickel, which require from metallurgists a consumption of coal double and sometimes triple that required in the metallurgy of iron.

Some of their plants are in full activity; among others, those, for instance, of the Société E'lectro-métallurgique de Frages, in France (Frages-Héroult process), those at La Praz (Savoy), at Frages (Isère) and in Sweden, where they are competing with the Kjellin process. I may add that they are already furnishing to the industries by hundreds of tons irons and steels of all kinds, and iron and steel alloys of every nature.

EDITORIAL COMMENT

LABOR affairs have demanded and received a large share of public attention during the past few weeks—"labor," that is, in the technical sense, in which it means a hierarchy of professional representatives, not always very wise or reasonable, to whom the rank and file have handed over the entirety of their interests. But amid all the turmoils and exasperations of the present deplorable and utterly wasteful system of strike and lockout, there are recurrent and increasing signs that saner councils and sounder leaders are gradually gaining. And it is in this direction that the hope of the future lies. Far-sighted manufacturers might well think carefully over the words addressed by President Mellen to his employees on the N. Y., N. H. & H. RR. a few weeks ago:—

> "I am going to surprise you by saying that I regard the unions as a condition that has come to stay; that I have no prejudice whatever to properly-conducted ones, and express my wish that our men generally would join them, not that I would run a union plant as such, for I would not coerce my men nor consent to discriminations as between those who were and who were not members, but I would wish to have in the unions the conservative influence of many of the good men who are out, to counteract the floater, the anarchist, the man who has nothing at stake in the world, who works with his mouth more than his hands.
>
> "My advice to you who have families, who have a stake in the world, is to join your unions, and make yourselves felt in them. Be always a force for conservatism. It seems to me as much in your interest to do this as that you shall attend the caucus and nominate good men for office and vote for them at the polls. Your apathy is the opportunity of the demagogue, the anarchist, the floater, who has nothing to lose."

The gist of the proposition is that unionism must be recognized as a permanently established institution. It has undoubtedly been necessary in the past, and sometimes is necessary still, to check its intolerance and its violence with a stern purpose and a strong hand. But the most effective treatment, the most rapid amelioration, will come from the internal influence of better men inside the unions.

* * *

THE most sensational development of late relating to the status of unionism is the much discussed decision of Judge Adams of the Illinois Appellate Court. In the case in question the unions attempted to enforce, by strike, certain most outrageous demands, and among them one for the exclusive employment of union men—in other words, the closed shop. They picketed the works, were enjoined, persisted, and were fined and the ringleaders jailed for contempt. The case came before Judge Adams on appeal. He holds that a strike to compel an agreement constitutes duress, is unlawful, and renders any agreement or contract obtained voidable; further—a much more important point—that the proposed agreement in this case would itself be unlawful because it would:—

> "if executed, tend to create a monopoly in favor of the members of the different unions, to the exclusion of workmen not members of such unions. * * * Contracts tending to create a monopoly are void."

The decision, naturally, has been sharply criticized, but it is said that counsel expect it to be sustained in the Illinois Supreme Court. If so, it will be one of the most important leading cases in the United States.

* * *

WITH the conclusion of the competition for the design of the United Engineering Building, to be constructed in New York for the use of the three National engineering societies which have accepted the generous offer of Mr. Andrew Carnegie, the work upon this important undertaking may be fairly said to be commenced. As has been announced in the daily and technical press, the successful contestant in the architectural competition is Mr. Herbert D. Hale, whose designs, subjected, with the others, to a most exacting scrutiny by the conference committee and their consulting architect, Professor W. R. Ware, were found to be most suitable for the conditions of the undertaking.

It is understood that four points were taken into account in making the decision, these covering the most important elements of the proposed structure: the façade, the main auditorium, the library, and the executive quarters for the several societies. Each design was considered as to each of these features, and by a process of gradual elimination the various plans were passed upon until the most satisfactory combination of all was found in the plans submitted by Mr. Hale. During this study the various designs were known only by numbers, the members of the committee being entirely in ignorance of the identity of the successful competitor.

Mr. Hale is to be congratulated upon the successful manner in which he has passed this severe ordeal, and there is no doubt that the completed structure will bear witness to the wise judgment of the committee and of Professor Ware.

In accordance with the suggestion of the joint library committee, the plans provide for the location of the general library and reading room upon the uppermost floor of the building, with such arrangement of top lighting as will make this portion a convenient and practical work room for the users of the valuable collection of books there to be assembled. The floor beneath is also to be devoted to the use of the library, so that ample space will be provided for this most important department in the work of the joint occupants of the building.

Scientific libraries are too often found to consist of valuable collections of books so guarded and hedged about with restrictions as to impair to a great extent their usefulness, but it is believed that in the new building on Thirty-ninth Street there will be found an engineering library which will be used as well as cared for, and which will become the standard centre from which information upon all branches of engineering will be disseminated over the whole country; while the resident or visiting engineer will find not only a courteous welcome, but also intelligent and cordial assistance in the conduct of his researches.

It is expected that work will speedily be begun upon the new building, and that its completion will not be long delayed.

REVIEW OF THE ENGINEERING PRESS.

"THE WORLD IS ITS FIELD"

INTERURBAN ELECTRIC RAILWAYS.

THE ADVANTAGES OF INTERURBAN ELECTRIC TRANSPORT AND THE CHANGES WHICH IT HAS WROUGHT IN THE TRAVERSED COUNTRY.

G. M. Walker—Street Railway Review.

ALTHOUGH the earliest ideas of electric transport were developed in connection with the substitution of mechanical for animal power in street railways, the extension of the electric railway to communication between neighboring towns has been a legitimate and important feature of its progress. The conditions which led to the successful development of interurban railways, and the precautions which should be taken with similar enterprises at the present time are very thoughtfully discussed in an article by Mr. G. M. Walker in a recent issue of the *Street Railway Review,* from which we make some abstracts.

"It should hardly be necessary at this late day to make any extended argument to prove the advantages and necessities of interurban railways. The convenience of their frequent service and its extreme cheapness have wrought such a change in farm life that wherever these interurban roads have been built there can hardly be said to be any country at all but that the whole region has become transformed into a great though scattering city.

"The farmer along the line of one of these roads enjoys at the cost of 15 or 20 minutes in time and a few cents in fare almost every convenience of the dweller in the city. He can go to town for business or pleasure at any hour of the day. His crates of fruit, barrels of vegetables and cans of milk are picked up at his door and landed in the city market within an hour or two of the time that they are taken, fresh. It is easy for his wife to go to town after her morning work is done and like the city housewife return from her marketing and shopping in time to get dinner, and it is no more inconvenient for the farmer and his family to attend the theatre or the opera than it is to any other dweller in the city's suburbs.

"In addition to this they place it within the power of the farmer to take advantage of every fluctuation in the price of his farm products and to place those products on the market without delay in time to dispose of them to the best advantage. To the city dwellers these interurban roads make possible the dream of years and they flee from the crowded cities to settle on two, three, or five-acre tracts along the line of these roads, there to enjoy in the midst of their gardens the pure air, the quiet and the healthful conditions of country life.

"In thickly populated communities these interurban roads have proved profitable investments to those who have built them while they have increased enormously the value of and demand for the lands through which they have run. As a rule all lands desirably located and within reaching distance of these interurban lines have doubled in value and increases from $50 to $100 per acre in the selling price of farms along these lines is common even where the distance from the city is so great as twenty miles."

These considerations have led to the construction of numerous interurban railways, and when the locations have been well selected the lines have been profitable to the original investors and also highly beneficial to the communities and districts through which they run. The best locations having been taken up, however, the question arises: How shall such railways be developed in sections which are too sparsely populated to attract capital? It is this question which Mr. Walker discusses at length, and while all may not agree entirely with his views, the points which he makes are those which must come up for settlement in actual practice.

There is no doubt that the residents of the communities along the line of a railway will be benefited by the opening up of their land, and farms which, with imperfect transportation facilities could be operated successfully only with staple crops in large bulk become available for division into small tracts for intensive farming as soon as cheap and rapid transport is provided. At the same time the capitalist cannot be expected to put money into the construction of a line through a district where the population is evidently insufficient to give a paying business from the start. In other words, each party is dependent on the other, and neither feels prepared to take the initiative.

Mr. Walker takes the position that the initiative lies with the residents of the district through which the railway passes.

"A community must pay the cost of its own development, and if it has reached the position where an interurban car service is necessary for its further development it must pay the cost of such a service. If this service is such as to require one thousand users at the ordinary rate of fare to make it pay, and the community has at present only five hundred such users there is no possible way by which the company furnishing such service can do so at ordinary rates except at a loss. The consequence is that if the community of five hundred users are to have this service they must pay for it the sum equal to the normal charge from one thousand users. This would necessitate a charge equal to double the normal rate which by making the fares high and the freight rates excessive would defeat the very purpose which they have in view, namely, to induce emigration into their community by furnishing it with transportation facilities at low cost."

As a comparison from an analogous situation Mr. Walker refers to the history of the development of steam railroads in the United States, showing that in localities west of the Allegheny Mountains private rights of way were offered to the railroads, and cities and towns vied with each other in their efforts to secure the construction of railroads to or through them. In the case of the State of Ohio, it appears that in the fifty years from 1850 to 1900 the miles of railroad increased from 575 to 8,768, while the population practically doubled from 2,000,000 to 4,000,000, and the wealth increased about eleven times, or from $500,000,000 to $5,800,000,000. Mr. Walker argues from these figures that the great proportional increase in wealth per capita was due to the development of the railroads, and while this may partially be the case it is more probable that the increases both in railroads and wealth were the results of the general development of the country, being themselves the results of a number of active and powerful causes, all tending in the same general direction. However this may be, there is no doubt that the prosperity of railways, whether steam or electric, is closely bound up with that of the country through which they pass, and that both should have common interests if the best advantages are to be realized.

"While the character of the traffic of these two classes of roads is different, the relative conditions of developing them are the same and the process which secured for the country its splendid systems of steam railroads must be pursued to secure the construction of the interurban electric railways that are now necessary to supplement the service of the steam roads and insure the continued growth of our country in produce and wealth.

"The idea seems to be widespread that electric lines are cheaper to build than steam railroads, but nothing could be farther from the truth. The right of way grading, ties and rails cost just as much for one as for the other, but at this point of the investment a steam railroad is ready to operate, while the electric line must invest a sum half again greater than the cost of all this to erect a pole line with overhead trolley and feed wires, while its power houses are far more expensive than locomotives and every electric car equipped with high power motors costs as much as an ordinary locomotive. This greater original cost of an electric line over the cost of a steam railroad is one of the things that makes it particularly necessary for the communities desiring them to contribute to the cost of their construction.

"In those localities where population and traffic are already sufficient to support these interurban railways they have been built. But those other localities without the necessary population and traffic must, in order to secure the construction of these interurban railways which are so necessary to their further development and prosperity, do as the government did in the case of the steam railroads; offer inducements to private capital to secure their construction, and these inducements or subsidies must be sufficient to reduce the cost of the road to the investors furnishing the funds to pay for its construction to a figure which the expected traffic will carry or to insure the operation of the road without loss until such time as it can build up a population and traffic sufficient to support it."

Although Mr. Walker assumes that the inducements to establish an interurban railway should come from the inhabitants of the communities through which it passes, he overlooks the fact that in many instances the capitalists who undertake the construction and operation of the road are themselves interested in the development of their own holdings along the line, and that it is not altogether an unknown plan for the investors in a railway to first become possessed of choice portions of land along the proposed line before the possibility of its construction has been made public. In some cases the projectors of a line expect to derive the greater part of their own profits from the increased value of their own land holdings along the line, leaving the other stockholders to wait for their returns until such time as the returns from operation warrants dividends. Such methods surely cannot be unknown to one so familiar with the other workings of railway development as Mr. Walker has shown himself to be. The real truth of the matter is that the best interests of the country are served in railroads as in other industrial developments, when those who use them are also those who profit by their use, and hence are most interested in their honest and capable exploitation and successful commercial development.

THE UTILISATION OF PEAT.

APPLICATIONS OF IMPROVED METHODS OF PREPARING AND COKING PEAT AND OF RECLAIMING BY-PRODUCTS.

Dr. L. C. Wolff—Verein Deutscher Ingenieure.

PEAT is a substance composed almost entirely of the decomposed remains of vegetation, principally certain mosses and allied plants, and it has been used for centuries as a form of inferior fuel. Within recent times, however, it has assumed an increasing importance, largely because of improved methods of preparing and using it, and hence a discussion of its properties and technical applications is a matter of interest. In a paper by Dr. L. C. Wolff, in a recent issue of the *Zeitschrift des Vereines Deutscher Ingenieure,* a study is made of the calorific power of peat fuel, together with some account of the modern methods of preparation, from which we make some abstracts.

Although peat is composed almost entirely of organic matter, it contains also nearly 90 per cent. of water, so that any attempts to use it in its natural condition give very meagre results, nearly all the heat evolved by the combustion being absorbed by the evaporation of the water. When the peat is dried in the air it retains only about 20 per cent. of water, and it is in this condition that it is generally used as domestic fuel by the peasants of Ireland and the Continent.

The later and more scientific methods of utilising this natural fuel involve a further degree of preparation than the mere drying of the mass. As originated by Ziegler, the modern method involves the coking of the dried peat, this furnishing a clean fuel standing about midway between charcoal and ordinary coke, and being free from sulphur and so especially suitable for certain metallurgical operations. The volatile matter is distilled off as gas, this furnishing more than enough heat by its subsequent combustion to effect the coking, while the condensible tarry residues contain valuable by-products. According to Dr. Wolff the products of the operation of coking are: coke, 27 per cent., tar, 4.5 per cent., tar water, 31 per cent., and fuel gas, 37 per cent. From the tar there may be extracted various oils, paraffin, etc., while the tar water contains wood alcohol, ammonia, and acetic acid, these latter being readily converted into sulphate of ammonia and acetate of lime, and thus rendered marketable products. Since the production of gas is in excess of that required for heating the ovens it may also be used for firing steam boilers, or the excess may be utilized directly in gas engines for the production of power. The calorific value of the gas is fairly high, since it contains about 15 per cent. of methane and 24 per cent. of hydrogen, determinations giving 2,877 calories per cubic metre, or about 323 B. T. U. per cubic foot.

Dr. Wolff gives some figures for the commercial side of the operation, from which he shows that 10 metric tons of coke, costing 50 marks, will produce coke and by-products worth 584 marks, which certainly should leave a margin for profit even after the operative expenses have been deducted.

Peat coke appears in many ways to be an ideal fuel. It has a calorific value of 7,889 calories per kilogramme, or 14,200 B. T. U. per pound, holds well together in the furnace, and produces a very small proportion of fine ash. It contains no sulphur, and hence is without injurious action upon boiler plates or heating kettles, and produces neither smoke nor smell. As a combustible it has all the advantages of wood charcoal, together with absence of friability, either in handling or in the fire, rendering it especially applicable for metallurgical operations.

Owing to the great extent of the peat bogs and moors in Germany and northern Europe generally, the development of commercial processes for its complete utilisation means much to the nations concerned. From a subordinate position, as the domestic fuel of a limited number of peasants, dwelling near the moors, it may become an important source of personal and national wealth, not only from its applications but also because of the employment which its exploitation will naturally give to residents of the land. The removal of the peat, so far from injuring the land, will make it better adapted to cultivation, and the entire operation offers such advantages as assuredly render it a matter for close investigation and technical as well as commercial study.

POWER STATION DESIGN.

GENERAL ARRANGEMENT, EQUIPMENT, AND SYSTEM OF OPERATION OF GENERATING STATIONS FOR ELECTRIC-POWER SUPPLY.

C. H. Merz and W. McLellan—Institution of Electrical Engineers.

A COMPARISON of a modern well-designed electric generating station with one representing good practice of a comparatively few years back must impress even the non-technical observer with the development which has been made in this important department of engineering work. The advances which have been made in electrical engineering are undoubtedly rapid, but a generating station really represents steam engineering, building arrangement and construction, mechanical transport appliances, and a vast multiplicity of mechanical details, together with the electrical portion of the equipment, and it is in the whole combination of a number of elements that progress has been made by application of the experience gained in practice. In a paper recently presented before the Institution of Electrical Engineers by Messrs C. H. Merz and Wm. McLellan, some of the salient features of modern power station design are discussed, and the paper, together with the animated discussion which it elicited, is of much interest and value.

The variety of electric generating stations renders it necessary for a single paper to be limited to some definite class, and the authors state at the outset that they propose to consider, in general, the requirements of a station of 5,000 kilowatts or over, of a general power-supply undertaking (power, traction and lighting) of a district extending over a considerable area. In the case of such a station economy must be considered, since the commercial success of the whole enterprise depends upon its ability to meet the conditions of price necessary to obtain customers.

A general power supply system should be considered as made up of two parts: the generating station and the distribution. These must be considered together, since the nature of the distribution selected controls very largely the character of the generating plant, but at the same time the two portions differ materially in their influence upon the economy.

The power station has hitherto occupied the greater share of attention of the designers of a system, but this is not warranted, since the distribution costs fully 50 per cent. of the total outlay, and it must in general be planned and put down with a greater margin for future extensions than is necessary with the station itself, since this latter may generally be begun on a moderate scale and extended as the demand requires. By allowing a sinking fund of 10 per cent. per annum to provide for future changes a fair provision may be made in this respect.

The main principles laid down for guidance in power station design are: simplicity of design; subdivision of plant and apparatus; arrangement of labor-saving devices, and provision for future extensions.

In considering the type of power generating plant to be used, the authors of the paper dismiss the reciprocating steam engine with scant mention, assuming as settled the fact that the only competitors worthy of consideration for the modern power house are the steam turbine and the gas engine.

"Steam turbines seem in every respect to be specially suitable for power scheme purposes, and although they have taken many years to develop, it is probable that had there been a demand ten years ago for 2,000 k.-w. generating sets, turbo-alternators would have been the only large-size generating units in extensive use at the present day. Their earlier commercial success was prevented by the fact that there was only a demand for small sizes (300 k.-w. and under), at which sizes any superiority which the turbine even at the present time possesses over reciprocating engines is due to saving of labour and oil rather than to either lower cost or reduced steam consumption. In large units the adoption of turbines materially reduces the capital cost of a power station. This reduction amounts to from 15 per cent. to 20 per cent. over the whole station even on present market prices, and it will be much greater when the manufacture of turbines has become as completely standardised as that of reciprocating engines. If the reduction be calculated on the engine and dynamo alone, the percentage is naturally very much greater. The mere fact that this saving is not available in small sizes greatly assists a power company in its competition with private plants, as a private user, utilising, as he must, relatively small units, does not reap anything like the same advantage as a power company from the adoption of turbines either in first cost or in steam consumption. We are here discussing a station for power supply which involves alternating units, as large continuous current turbo-generators, due to the troubles of commutation at high speed, have still a somewhat limited field.

"The high thermal efficiency of gas engines has long rendered their use attractive to power station engineers, more especially in the south of England, where coal is expensive, but, although we may eventually look forward to the time when a gas motor fulfilling the requirements of a power station will be obtainable, it can hardly be denied that, for this purpose, the gas engine has not at present attained the same perfection as the steam turbine.

"Apart altogether from the importance of utilising more efficiently the heat energy in coal, there are large possibilities in utilising gas which is a waste product, or which is obtainable in conjunction with some manufacturing process. These possibilities make it particularly desirable to utilise gas direct in the prime mover without the agency of steam. This paper, however, refers essentially to the design of power stations where coal is the fuel, either in a boiler or in a gas retort. The conclusions drawn under this section must in no sense be taken as implying that in the opinion of the authors gas engines are impracticable for power stations where waste gas from blast furnaces or other source is available."

The general arrangement of the plant includes the location of the generating station, which should be well within the area to be supplied, unless questions involving the supply of materials, water, gas, etc., become of controlling influence and favor a location at the extreme boundary. The structure itself should be treated merely as a shell to contain the generating plant effectively, but as cheaply as possible. A steel-framed structure, with brick, concrete, or corrugated iron sheathing is probably the most satisfactory.

In considering the general lay-out of the buildings the modern station is tending toward what may be called the complete unit system. This does not necessarily mean that each unit consists of but one generating set, but that the plant is divided into separate sections, each section consisting of the steam, power, and electric machinery of a certain portion of the whole, so that any interruption of one unit would have no effect upon the others. This does away with the steam main into which all the boilers feed and from which all the engines draw their supply of steam, as in the older plants, and makes the power plant an aggregation of independent units. The buildings should consist of three components: the boiler house, or gas-generator house; the engine room, which is also the room for the electric generators, and auxiliaries; and the switch galleries, or separate switch house. By arranging these components along three parallel lines they may be extended in a systematic manner, as may be required. Illustrations of several executed designs showing this plan are given in the paper, and especial stress is laid upon the manner in which the steam turbine is adapted to such service. The system of separate units also makes the provision of spare plant a part of the whole, since the installation of one or more units in addition to the immediate requirements furnishes the reserve equipment along the line of further extension. The size and number of units must in all cases be determined by the operative requirements of the service. Single generating sets of 1,500 to 2,500 kilowatts output, with a capacity for 50 per cent. overload, have been used with success, generating three-phase current of 40 or 50 cycles, at any convenient voltage, transforming as may be required by the service.

Although no precise figures as to installation costs are given in the paper, it developed in the discussion that the entire cost of such a station as is outlined is considerably below £20 per kilowatt.

INTERNAL COMBUSTION MOTORS.

IMPROVEMENTS AND DEVELOPMENTS IN GAS, OIL, AND PETROLEUM ENGINES DURING THE PAST TWENTY YEARS.

Dugald Clerk—Institution of Civil Engineers.

IN engineering, as in other fields of work, the lines along which progress may best be made are often indicated by a study of the past, and in this respect, as well as for its general importance, the James Forrest lecture of Mr. Dugald Clerk, delivered before the Institution of Civil Engineers, demands attention and comment. Mr. Clerk is pre-eminently fitted to discuss the subject of internal-combustion motors, he having been one of the ablest pioneers in this important line of work, and himself being the inventor of many improvements in such machines. Both as an engineer and as an author he has shown himself to be an able specialist in this field, and there is to-day no one better qualified to speak with authority upon the subject.

Referring to the work of the past twenty-five years, Mr. Clerk says:

"Development has followed two main lines. First, improvements relating to the motor itself, including changes in the thermodynamic cycle, followed in the treatment of the working fluid and the inflammable gas within the motor by the modification of such details as admission valves, igniting devices, governing devices, and water and air-cooling devices. Starting gear has also been carefully studied, and, both from the thermo-dynamic and the mechanical point of view, it may be safely said that these motors have attained a great measure of perfection. Secondly, parallel with the improvements relating to the motor itself have proceeded those relating to means of generating the inflammable, gaseous, or vapor fuel intended to operate the motor. These improvements have related to the economical production of ordinary coal gas, to the effective production of producer gas from anthracite, bituminous non-caking coal, coke, and other solid fuels, to the treatment of heavy and light hydro-carbons and alcohol to produce an effective inflammable vapor, and to the purification and collection of blast furnace gas, coke oven gas, and natural gas."

In examining the performance of internal-combustion engines the heat which is supplied by the fuel reappears in three portions. One part is converted into mechanical energy, and is available for application to useful purposes. Another portion is carried off without change by the water which circulates in the cylinder jacket, while the third goes out the exhaust pipe with the discharge of the contents of the cylinder. The water-jacket for the cylinder is a mechanical necessity, since without it the working parts would become so overheated as to interfere with their operation, while the discharge of the heat in the waste gases is an obvious necessity, to be minimized if possible, but not to be entirely prevented. Mr. Clerk tabulates various gas engine tests from 1882 to 1900, giving the heat balances, these showing the extent to which the relation between these various quantities of heat has been changed by improvements in the engines built during that period.

Thus, in 1882 tests made by Slaby showed only 16 per cent. of the heat was converted into useful work, while 51 per cent. was carried off in the cooling water. Gradually the proportion of heat utilised has been increased until about 30 per cent. has been attained, while there has been a continual decrease in the amount of heat carried off by the jacket. At the same time the proportion passing out with the exhaust gases has increased, so that there has been what may be called a redistribution of the heat.

"To understand the reasons for this it is necessary to consider briefly the thermodynamics of this subject so far as it is at present understood, in order to see whether further knowledge is required to enable the meaning of the relative losses and gains in these engines to be better appreciated. Although the general thermo-dynamics of the internal-combustion motor may be considered to be broadly understood, yet physical and chemical knowledge of the properties of air and other gases at high temperatures is as yet insufficient to enable the physicist or engineer to formulate a quantitatively accurate standard engine of comparison; that is, to formulate a conceivable engine in which all heat losses by conduction and radiation are suppressed, and where the efficiency is the full efficiency of the particular cycle under the assumed conditions, whether perfect or imperfect.

"The present position of the theory of the internal-combustion motor is in the state of that of the steam engine at the time of Watt, before the accurate determination of the properties of steam. As Watt knew of the latent heat of steam, but did not know all its properties accurately through a considerable range of pressures and temperatures, so engineers now know of a similar absorption or suppression of heat existing in gaseous explosions without knowing accurately its causes or proportions under all the various conditions of practice. It is perhaps in this task of settling the data for an accurate standard engine of comparison that the physicist and chemist can assist the engineer most effectively. So far, by following the broad lines indicated, heat efficiencies have improved from 15 per cent. to 30 per cent.; and, without doubt, further improvement in efficiency will be made, but with present knowledge it would be impossible to say that the next twenty years would carry us from the 30 per cent. efficiency of to-day to, say, a 60 per cent. efficiency. That efficiencies can be increased much further cannot be doubted. This is evident from an examination of the change in efficiency which may be produced under certain conditions in an engine operated by pure air.

Such a standard was first proposed by me in a paper read before the Institution in 1882. In that paper it was recognized for the first time that a standard most nearly approximating to practical conditions of that day would give constant efficiency for a given compression volume for all maximum temperatures above the temperature of compression. The standard engine of comparison, which would correspond most closely with to-day's practice, is an air-engine operated between a maximum and minimum volume as follows:

"Adiabatic compression of air from maximum to minimum volume; addition of heat at minimum volume, raising the temperature from the temperature of compression to the maximum temperature; adiabatic expansion to maximum volume, and discharge of heat at maximum volume."

If it is assumed that the specific heat of air is constant throughout the entire temperature range, the efficiency will be constant for all maximum temperatures; that is, for all heat additions above the temperature of adiabatic compression. Taking air as the standard, Mr. Clerk computes the maximum efficiencies possible for various degrees of compression, showing that for a compression of one-half the efficiency will be 0.24, while for 1.100 the efficiency may become as great as 0.85. In present practice compression has been carried as high as 1.7 to 1.10, and the corresponding efficiencies are 0.55 and 0.61. It is not to be expected that these theoretical efficiencies can be realized in practice, since constructive and mechanical difficulties are in the way. A comparison of recent tests, however, show that from 0.5 to 0.6 of the standard efficiency of the air engine, operating at the same compression, may be attained with existing designs. In order to obtain the best efficiency the cylinder should be cooled as little as possible, and the compression should be carried to the highest practicable point. Although Mr. Clerk does not mention the fact these points are the very ones which have been followed by Herr Rudolph Diesel in the design of his motor. Diesel has gone so far as to advocate the entire abandonment of the water jacket, although this has not been found desirable in practice, while he carries the compression to a higher point than has been attempted by any other designer. The real difficulty about high compression with the ordinary mixed charges is the danger of pre-ignition from the heat of compression, as Mr. Clerk very clearly points out. Since Diesel compresses only the pure air, and does not inject the fuel until the end of the compression stroke, he experiences no trouble on this score, while at the same time the heat of compression insures an immediate ignition, and avoids the necessity for any independent method of ignition. For other forms of internal-combustion engines, however, the limitations of compression by fear of pre-ignition constitute a distinct barrier, especially with large engines. Any attempt to prevent this trouble by excessive cooling reduces the efficiency by reason of the greater portion of heat carried off by the jacket water.

"The internal combustion motor offers, perhaps, the best instance of international industry which could be imagined. England stands at the head of all nations in the production of the smaller and medium-sized fixed gas engines. She has produced altogether something approaching 100,000 engines of an average of 20 horse-power This is greatly in excess of the whole Continental output of engines of this type taken together. On the other hand, Continental engineers have given more attention to the large gas engine—engines of 500 horse-power and above—and the application of blast-furnace gas to the use of the large engine. In this field of internal combustion motor work Germany excels.

"In the petrol motors for motor carriages France appears to take the lead, and in heavy oil engines England takes the lead. In America engineers are now giving considerable attention to the internal combustion motor; but so far, for some reason, the Americans have not shown in this subject the inventive and progressive spirit which they usually display. They have, however, taken considerable part in the application of petrol motors to small vessels and boats.

"It may be said, however, without exaggeration, that the whole world is now alive to the possibilities of the internal combustion motor, and that progress will be more and more rapid. These motors have almost fulfilled the expectations of those engineers who—like myself—have devoted a large part of their lives to their study and advancement. They are looking forward now to the completion of the work begun so many years ago, and expect, at no distant date, to find the internal combustion motor competing with the steam engine, even in its latest form, the steam turbine, on sea as vigorously as it does at present on land."

It will be interesting to compare the views thus expressed out of the ripe experience of Mr. Clerk about the relation of the gas motor to the steam engine with those of the authors of the paper mentioned in the preceding review. The gas engine has certainly made rapid progress of late, and it will hardly do to dismiss it with brief mention, as if it were a mere toy.

THE REVERSIBILITY OF THE HYDRAULIC TURBINE.

A SCIENTIFIC STUDY OF THE RELATION OF THE HYDRAULIC WATER WHEEL TO THE CENTRIFUGAL PUMP.

Platon Yankowsky—Revue de Mécanique.

WE have heard much of late about reversible and non-reversible cycles in heat engines, although there is apparently room for further discussion in that direction. We now have an important and interesting paper, by M. Platon Yankowsky, of St. Petersburg, published in a recent issue of the *Revue de Mécanique,* examining the theory of what M. Rateau has called "turbo-machines," and showing the extent to which such machines are reversible. Professor Yankowsky confines himself to hydraulic machines, and takes up the equations of Herrmann and elaborates the theory in a most interesting manner. For the mathematical development the reader must be referred to the original paper, but the general consideration of the subject may be examined here as having interest to the engineer for various reasons.

If we have a flow of water from a higher to a lower level there is developed mechanical energy theoretically equal to that necessary to raise the same volume of water to the same height in the same time. If we place in the path of the descending water a piston hydraulic engine it will be driven, while a piston pump, placed in the pipe may be used to elevate water if driven by some external source of power. The use of a turbine to take the power from the falling stream, or a centrifugal pump to raise the water in the second instance, does not change the general nature of the problem, if the efficiency of the machines remains the same. If, however, the efficiency be considered as a variable element the matter demands further study. The piston hydraulic motor may be considered, theoretically, as having an efficiency of unity, and the same may be said of the piston pump; friction and leakage being, for the moment, neglected. When we take the efficiency into account, however, the limitations or reversibility become apparent.

Taking the original equations of Weisbach as modified by Herrmann, and using the constants of Zeuner, Professor Yankowsky shows that the difference between the fundamental formulas for a turbine and a centrifugal pump consists only in the change of sign for certain terms. It is evident, however, that no matter how low the efficiency of a turbine, it will continue to act and to deliver its corresponding proportion of mechanical energy upon the shaft. When a turbine of low efficiency is used as a pump, however, the energy which does not appear in useful work is absorbed in the internal resistances, and hence it is necessary that the efficiency shall be greater than the internal resistance if any pumping action is to be obtained. This agrees fully with the mathematical deduction from the equations, which show that a condition of reversibility is that the machine, considered as a motor, must have an efficiency of more than 50 per cent. There is an analogy in this respect with other mechanical devices. Thus the differential chain block hoist, as is well known, will hold its load suspended, without "overhauling" or running back, and this property has been shown to be dependent upon the fact that it possesses an efficiency of less than 50 per cent. In the case of the more modern hoisting machines, having efficiencies of more than 50 per cent., it is necessary to provide some form of brake, usually thrown out of action automatically during the operation of hoisting, otherwise the load will not be sustained when the hoisting power is removed.

Another way of putting the question is found in a formula similar to the well-known proposition of Carnot relative to the efficiency of heat engines. Thus, if T be the useful work of the machine, considered as a pump, and t be the work lost in overcoming internal resistances, the maximum effect of the machine will be given by the expression:

$$\frac{T - t}{T}$$

Now when the efficiency of the machine is 50 per cent. the useful work and the opposing resistance are equal to each other, and the numerator of the above fraction becomes zero, and hence its value will also be zero and the device becomes inoperative.

Professor Yankowsky shows that the division of turbines into the two classes of reaction and impulse wheels bears an important relation to the question of reversibility. The reaction turbine, acting by the pressure of the water, is a reversible machine, while the impulse wheel is irreversible. Thus a wheel of the Fourneyron type may, without change, be converted into a pump, and this experiment has been successfully tried by Professor Yankowsky in his laboratory at the Institute of Ways and Communications at St. Petersburg, although the turbine was one of an old type, built in 1860, and without any such reversed action in view. It is evident, however, that an impulse turbine, such as the Pelton wheel, is irreversible, and that driving it backward by an external application of power would produce no pumping effect.

The important object which may be attained by the study of the reversibility of turbines lies, not so much in the fact that the thing can be done, as that it forms a basis for a scientific investigation of such machines, with a view to their increased efficiency. Since the perfectly reversible machine must be one having an efficiency of unity, any improvements in design directed to the attainment of the best action both as a turbine and as a pump must conduce towards the maximum efficiency, and when the perfect reaction turbine is produced it should also be the perfect rotary pump.

An interesting analogy to this hydraulic problem is seen in the corresponding question in electric generation and application. The fact that the dynamo is a reversible machine is the reason for the existence of the electric motor in its analogous form, and the completeness of the reversibility accords fully with the high degree of efficiency of both machines.

The extensive use of the principle of reversibility for testing the accuracy of many scientific instruments is well known, and it will be an interesting parallel if it appears that the test of reversibility of action is established as a general principle in machine design.

PROGRESS ON THE JUNGFRAU RAILWAY.

THE CONSTRUCTION AND OPERATION OF THE FIRST PORTION OF THE ELECTRIC RAILWAY FROM INTERLAKEN UP THE JUNGFRAU.

L. J. Sidler—Génie Civil.

JUST six years ago there was reviewed in these columns an account of the proposed electric railway to the summit of the Jungfrau, in Switzerland, and at that time it was hoped that the completion of the work would not occupy more than five or six years.

We now have an account of the railway and its operation, not indeed to the summit, but to the station Eismeer, or sea of ice, situated at an altitude of 3,161 metres (10,371 feet) above sea level, the altitude of the summit of the Jungfrau being 4,166 metres, or 13,668 feet above sea. This portion, representing 5.66 kilometres of the total of 12.5 kilometres distance between Little Scheidegg and the summit, is now in regular service, there being six electric locomotives in use, deriving their power from the hydro-electric station at Lauterbrunnen on the White Lütschine; the second station at Burglauenen, on the Black Lütschine, not yet being completed.

The constructive difficulties of this portion of the road represent by far the most important of the work, and there is every reason to believe that the remainder will be completed without any serious delay. The Little Scheidegg, the starting point of the electric railway up the mountain, is the terminus of the steam railway between Lauterbrunnen and Grindelwald, connecting also with Interlaken, this latter being the point from which probably most of the tourist travel will originate. Although the summit is not yet attained, the portion of the road already completed affords some magnificent views of the alps of the Bernese Oberland, and from a description of the railway recently published by M. L. J. Sidler in *Le Génie Civil* we abstract some account of the work and its operation.

After passing the station Eigergletscher, from which a fine view of the numerous peaks of the Bernese Oberland is obtained, the road passes into a tunnel about 10 kilometres in length, in which there are three stations, these being situated in chambers cut out of the solid rock, and provided with rooms for the buffet and for the attendants, and having openings like windows through the mountain side from which the landscape without may be seen. From the Eismeer station, at the outlet of the tunnel, the railway will proceed at the moderate grade of 6 per cent., to a point immediately beneath the summit, from whence a vertical lift of 73 metres will be constructed to carry the passengers to the extreme summit. The maximum grade of the portion of the road already built is about 25 per cent., while the uncompleted portion, about one-half of the actual road length, is less difficult and will doubtless be executed without material delay.

To the engineer the most interesting portion of the work is that of the power development and the operation of the electric locomotives. This is especially the case because the installations represent the work of several establishments and of varying methods of construction. In the Lauterbrunnen power station there are two kinds of turbines, constructed on the Girard and the Francis systems, these operating under a head of 35 metres, and generating a total power of 2,650 horse power. The dynamos, generating a three-phase current at 7,000 volts, are by the Oerlikon Works, and by Brown, Boveri & Co., of Baden. Since the water supply for the turbines becomes insufficient during the winter, when the melting of the glaciers ceases, an auxiliary power plant, consisting of two gas engines, with a fuel gas producer, is also provided. At each station there is a transformer equipment, lowering the voltage from 7,000 to 500 volts, at which latter pressure the current is delivered to the motors on the locomotives.

The electric locomotives at present in use on the Jungfrau railway present several features of interest. There are six machines in operation on the portion already completed, three of these being built by Brown, Boveri & Co., and three by the Oerlikon Works. Mechanically the engines are identical, but there are material differences in the electrical details. The six locomotives may be divided into three classes, according to the method of control used during the descent of the train. In two of the locomotives the non-synchronous motors, being driven by the weight of the train, act as generators, delivering current to the main line. A third locomotive is similar in action, with the provision of a variable resistance which may be inserted to absorb to a greater or less degree the energy developed by the descent of the train. Experience with these locomotives showed that with the small number of trains in operation and the proportionately large amount of power developed during the descent, there were occasions in which the generating station was entirely relieved of load, the dynamos then acting as non-synchronous motors and causing serious difficulties in the operation of the plant. It was therefore thought desirable to arrange the locomotives so that during the descent they might be entirely independent of the power station, the energy developed by the descending train being entirely absorbed in the locomotive itself. It was with this idea in view that the fourth and fifth locomotives were constructed by the Oerlikon Works, and the sixth machine by Brown, Boveri & Co. In the first two machines the motors are also arranged to operate as generators, but the primary windings are not traversed by the three-phase current of the line, but are supplied with a continuous current generated by a small six-pole dynamo, mounted upon the shaft of one of the motors. The sixth engine is constructed on a different principle, the non-synchronous motors acting, during the descent, as continuous-current series dynamos.

The mechanical features of all the locomotives demand attention, especially in connection with the appliances intended to provide for the safety of the passengers. Each locomotive is provided with two electric motors, and each motor has a double train of gearing to the rack rail, so that the breakage of any part cannot interrupt the connection. The wheels gearing into the rack between the rails are mounted on separate axles from those of the supporting wheels running on the rails, so that the latter axles are free from any stresses due to the power transmission. The methods of arresting the descent of the locomotive are ample, in excess of any demands, there being three independent systems. The first of these is the system of electric resistance, by which the motors are operated as dynamos, under load, as already described, and this is intended to be the usual method of regulating the speed of descent. In addition to this there are two independent systems of mechanical brakes, the first consisting of two sets of brake shoes clamping by a screw movement against drums mounted upon the main motor gears, and the second being an automatic strap brake, acting directly upon a drum on the motor shaft, and thrown into action automatically whenever the the speed rises 25 per cent. above normal. These brakes act through the train of gearing upon the rack between the rails, but in addition to these there is an entirely separate safety clutch, which grips directly upon the smooth sides of the rack rail, so that it can be used in the event of any breakdown of any part of the duplicate system of gearing.

Although but one-half of the road is open to traffic the results have been very satisfactory, and during the past summer of 1903 nearly 30,000 passengers were carried to the Eigergletscher station. That the traffic will be greatly increased when the road is completed to the summit cannot be doubted, and the experience which has been gained in the construction and operation of this first portion will doubtless aid materially in the development and maintenance of the whole undertaking.

THE MEASUREMENT OF POWER.

DIRECT READING DYNAMOMETERS FOR THE DETERMINATION OF THE POWER DEVELOPED BY HIGH-SPEED MOTORS.

Col. Ch. Renard—Comptes Rendus.

IN determining the power developed by prime movers several methods have come to be accepted as standard. For the steam engine the indicator permits the mean effective pressure in the cylinder to be measured in a satisfactory manner, while with certain modifications, this instrument has also been used for the internal-combustion motor. With this last machine, however, the fact that the power developed by succeeding strokes may and does vary materially, so that readings form a number of consecutive strokes are necessary in order to enable a reliable determination to be made, and hence the continuous indicator has been devised for such purposes. At the same time it has become generally recognized that the most reliable method of measuring the power developed by an internal-combustion motor is that of the absorption of the entire power by some form of friction brake, the turning force and its moment giving the data necessary for the computation. For the steam turbine, the indicator is, of course, entirely inapplicable, and the power of such machines is generally determined, either by the brake, or by the measurement of the electrical energy developed in the dynamo which it drives, this, naturally, including the mechanical and electrical efficiency of the machines.

The advent of the small, high-speed internal-combustion motor, such as is used for automobiles, motor boats, and dirigible balloons, has created a demand for some form of apparatus which shall enable the power developed to be accurately and readily measured. The rotative speed of such machines renders the application of the ordinary form of indicator entirely impracticable. Certain special forms, with the piston replaced by a diaphragm, and the arm and pencil, by a mirror and beam of reflected light, have been employed, but such devices are adapted only for the mechanical laboratory, and have but a limited application. For these reasons the improved dynamometer, devised by Col. Ch. Renard, well known for his experimental work in practical aeronautics, and described in recent issues of *Comptes Rendus,* is of especial interest and importance.

The principle of the dynamometer devised by Col. Renard is so simple that it is a matter for surprise that it has not been employed for this purpose before. It consists merely in the utilization of the resistance offered by the air to the rotation of revolving arms upon which suitable vanes are mounted. As a regulator of velocity this device has long been employed in connection with such well known machines as the striking mechanism of clocks, or the driving gear of musical boxes, but its employment as a measuring apparatus of precision is another matter. Col. Renard, however, has subjected this simple device to a series of exhaustive tests, and has verified the fact that the power which it absorbs is practically dependent upon the area and form of the vanes, the density of the air in which it revolves, and the square of the speed of revolution. For a constant form of vane, therefore, and a constant density of air, the power absorbed by such a windmill is measured solely by the speed. Since the speed of rotation is limited only by the construction and strength of the materials, and the heat is carried off continually by the air, the device is especially adapted for the direct measurement of the power developed by high-speed automobile motors, and machines of similar character, to these it has been applied with great success.

In the machine illustrated and described by Col. Renard the dynamometer consists simply of a pair of arms, carrying square vanes of aluminum, this being placed directly upon the shaft of the motor. The motor is then allowed to run at the maximum speed which it can make against the air resistance thus opposed, and the power developed is computed from the speed. A little experience will enable the vanes to be so proportioned as to offer sufficient resistance to hold the motor to the desired working speed, and the dynamometer thus proportioned may then be calibrated to determine the power which it absorbs at various speeds.

The calibration of such a windmill dynamometer is readily effected by what Col. Renard calls a dynamometric balance, an ingenious modification of a principle already applied for another purpose. This balance consists of an electric motor suspended in such a manner that both the armature and the field are free to revolve. The frame, carrying the field, consists of a sort of scale beam, with pans in which weights can be placed. The windmill dynamometer to be calibrated is attached to the shaft of the motor and rotated, while the field is kept from revolving by placing weights in the scale pan. It is evident that the weight necessary to maintain the field stationary is a measure of the torque opposing the windmill, and thus the value of the constant for the dynamometer under test can be accurately determined. In this manner Col. Renard has constructed diagrams from which the power absorbed by his dynamometer for any given speed may be read at once, and it is only necessary to provide the machine with a reliable speed indicator to enable it to be used without any computations whatever.

Apart from the convenience of the apparatus for measuring the power of high speed motors, it having been used with satisfaction for machines up to 20 horse power, it has been used for investigations upon the resistance of the air to the motion of bodies of different shapes, and it may thus become a means of solving some of the problems in connection with aerial navigation. Its use has already demonstrated the correctness of the law that the resistance of the air varies as the square of the velocity, thus confirming the researches of Le Dantec, Canovetti and others.

The successful solution of the problem of the navigation of the air will probably be made by the development of apparatus which shall enable all the elements of the problem which are at present indeterminate to be accurately measured and investigated. For this reason the apparatus of Col. Renard demands attention and study, apart from its immediate practical uses.

SPACE DISTRIBUTION OF TIME.

THE PRECISE REGULATION OF TIMEPIECES OVER A LARGE AREA BY SPACE TELEGRAPHY.

G. Bigourdan—Comptes Rendus.

SEVERAL months ago we referred in these columns to the proposals of Mr. Nikola Tesla for the distribution of energy through space by means of magnetic waves, and noted his suggestion that any number of clocks might be operated in precise synchronism over a large area in this manner. It now appears that this has already been accomplished, and in a paper recently communicated to the French Academy by M. G. Bigourdan, and published in *Comptes Rendus,* the experiments are described.

The electrical distribution of time is by no means new, and both in Europe and America standard time is transmitted from the official observatories by means of master clocks fitted with electro-magnetic devices and connected by wires to receiving instruments in various cities. In the United States this method of synchronizing clocks is also used in large manufacturing establishments, in connection with mechanical time recording devices for workmen, this preventing any suspicion of irregularities or tampering with the mechanical timekeepers in the different departments.

The applicability of space telegraphy for this purpose extends its scope immensely, and since the object is attained simply by the transmission of uniform impulses it is really one of the simplest applications of the method which can well be imagined.

The experiments described by Mr. Bigourdan were conducted by him in connection with apparatus made for the purpose by Ducretet, the whole being very simple in design and action. A master clock was arranged to make and break an electrical contact every second. This operated a relay, which in turn discharged current into the primary circuit of an induction coil provided with an oscillator. The secondary circuit of the coil thus gave an oscillating discharge of very brief duration at regular intervals of one second. The two poles of the coil were connected, one with the earth and the other with an antenna of several metres in height, and by this means the electric waves acted upon a number of receivers, these latter beating regularly at intervals of one second in accordance with the action of the master clock. Two forms of receivers were employed, one being simply a radio-telephone of the Popoff-Ducretet system, in which the seconds beaten by the master clock were very clearly heard. The other form of receiver was similar to that of a space telegraph system, the Morse receiver being replaced by a recording chronograph with pen and travelling strip of paper. These operated in a very satisfactory manner, and with the paper moving at the rate of one centimetre per second the time could be recorded with a precision of 0.02 to 0.03 second.

Although the apparatus employed by M. Bigourdan in his experiments was very modest in its proportions it gave excellent results over distances of 2 kilometres, and would doubtless have served for greater distances had opportunity offered to install the receivers.

There appears to be no doubt that such a device as it was would answer perfectly for the electric distribution of accurate time over the entire area of Paris, and even to points beyond in the suburbs.

There are certain details to be observed in connection with the operation of the apparatus, such as the starting of the zero time at all points together, and the use of interruptions in practice at intervals of 10 or 12 seconds, in order to regulate the minute hand of the clock uniformly, but these are details which appertain only to the distribution of standard time for general use. For astronomical observations it would probably be better to send out the pulsations second by second by the observatory clock, and make the necessary instrumental corrections for the receiving chronographs afterwards in connection with the reduction of the observations.

The advantages of the space distribution of accurate time can hardly be overestimated, since the method obviates entirely the chief difficulty which has been found in the usual employment of electricity for this purpose, that is, the necessity for running connecting wires to the point under consideration. The experiments of M. Bigourdan, it is true, covered but a small area, but the possibility of transmitting magnetic waves even across the Atlantic ocean has already been demonstrated, and it can readily be seen that a regular wireless time distributing service from Greenwich Observatory, for example, might be received by every vessel on the ocean lanes, merely by the installation of a receiver on each ship. Such a service would replace the chronometers, or rather supplement them to an extent which would render any deviation from the correct time impossible, and enable the longitude to be determined with a precision otherwise unattainable. In like manner the time might be transmitted over the entire width of a continent, such as Africa, and the explorer in the desert would be aided in determining his position with the additional use of but a few portable instruments.

It has been suggested that the exploitation of the remaining portions of the earth may finally be accomplished by methods of slow approach, establishing stations which shall each year approach nearer and nearer the goal, whether this be the North Pole, the Antarctic, or the interior of a continent, and one of the conditions of such a gradual conquest of the last terrestrial problems is admitted to be the necessity for the transmission of intelligence and energy. With the extension of the space distribution of energy, of which the above is but a trifling example, this portion of the equipment will be supplied, and the rest will not be slow to follow.

THE HEAT TREATMENT OF STEEL.

PRACTICAL EXPERIENCE IN THE PRODUCTION AND THERMAL TREATMENT OF STEEL IN LARGE MASSES.

Cosmo Johns—Iron and Steel Institute.

LABORATORY experiments and investigations are of the greatest value in metallurgical operations, but the difficulties of reproducing processes in the works upon a large scale frequently prevents the attainment of results which, in theory, are strictly correct, and which are readily produced on the small scale used by the scientific investigator. This side of the subject is often overlooked, and for this reason the paper of Mr. Cosmo Johns, presented at the recent meeting of the Iron and Steel Institute, is of much practical value.

"First, of all, the mass of the steel that happens to be under treatment plays a most important part, for heat takes an appreciable time in its transmission through the mass. Now, in a small laboratory specimen the mass plays a very insignificant part, the element of time is reduced almost to zero, and such terms as "rapidly heating," "cooling quickly in air," have a very definite meaning. It so happens, however, that the steel products in whose manufacture heat treatment plays a part are all of considerable size. For instance, a railway-axle weighing 500 pounds offers a mass that is out of all proportion to the small specimens often experimented upon, and yet axles are about the smallest of the steel products of the works whose methods the author is about to describe briefly.

"From an axle weighing 500 pounds to a marine shaft 26¾ inches external diameter and 86 feet in length is a stride that at once calls attention to the new conditions imposed. To ensure the homogeneity of a mass of steel like this is a problem of itself, having regard to the effect segregation of the elements plays in even moderate masses of steel; while to heat equally to a predetermined temperature, and then to cool it at a certain rate, are operations that tax the resources of the metallurgical engineer.

"Yet these, after all, are comparatively favorable examples. Certain steels are fairly easy to work and to treat in small masses, but when the mass is increased it becomes very difficult. Any attempt to heat or cool them rapidly would result in external or internal fractures. Take, for instance, a carbon steel, containing 0.60 per cent. carbon; in attempting to forge a shaft, say, from a 40-ton ingot, the variation of temperature during the forging would induce stresses in the interior that in all probability would result in internal fractures with disastrous results when the shaft was used. Even with much lower carbon steels the same difficulties are met with, though to a less degree, and the mere heating or cooling of large masses of steel, 40 to 100 tons in weight, is a very delicate operation. Any attempt to accelerate the heating would cause the exterior to expand faster than the interior, and thus cause an internal fracture. A similar attempt to hasten the cooling would cause the exterior to cool faster than the interior—resulting in fracture again. But there are alloy steels even still more difficult to work. When large masses of these are treated they have to be kept in a heated condition until worked into their final form, and even then losses through fracture or 'clinks' are not uncommon.

"Then, again, time is a very important factor in thermal treatment. If a small laboratory specimen and a large forging be subjected to the same treatment, the resulting structure will be very different, even though the small specimen had been originally a part of the forging and was thus of the same composition.

"The explanation is clear. Suppose that both had to be heated to 1,650 degrees F. and dipped in oil, the cooling would be very rapid in the case of the small specimen, but in the case of the large forging the exterior would be quickly cooled, while the transmission of heat to the cooled exterior from the still heated interior would continue to take place for a considerable time. If the cooling were done in air the same difference would arise, and what was accomplished in minutes in one case would take days in the second. It is well, therefore, that this question of "mass" should be clearly recognised. One of the first lessons learnt in works practice is, that a course of heat treatment eminently suitable for a small specimen as determined in the works laboratory requires to be carefully revised, and the new factors of "mass" and "time" allowed for, before satisfactory, results are obtained with large masses.

"But 'mass' and 'time' are not the only elements that serve to differentiate works from laboratory practice. The manufacturer generally has to work to a specification, with rigid chemical and physical limits for his product. The author prefers not to enter into the vexed question of the expediency of these limits. The fact remains, that the specification has a very real existence and must be followed, but it also means that it limits the results that have to be aimed at and it is not always the ideal that is attained.

"To 'mass' and 'time,' therefore, must be added the 'specification,' and then we have the chief differences between the problem that presents itself in the works and the results of patient laboratory experiments."

As illustrating the practical application of the modern methods of steel working and heat treatment, Mr. Johns discusses the practice of the River Don Works at Sheffield, limiting himself to tires, axles, and shafts, and omitting discussion of armor-plate and projectiles, or of steel castings.

An important element in the production of homogeneous steel is found in the arrangement of the ingot mould to prevent segregation and blow holes.

"The moulds are made of cast iron, with an upper portion of non-conducting material, designed so that the body of the ingot may solidify and be fed by the still liquid head. This head, being the last portion to solidify, serves to include the region of segregation, with the result that the top and bottom of the body of the ingots show very little variation in composition. If the entire mould were lined with non-conducting material many of the difficulties encountered in making large ingots in chilled moulds, would be removed, but there would be the objection that the ingot would solidify more equally over its mass, contraction cavities might be formed in the portion destined for use, while the region of segregation would probably occur there also.

"Needless to say, fluid compression is not used. It may seem late in the day to urge objections against the idea, but as in one or two quarters there remains a tendency to see some value in the process, it might be as well to state again the chief objections.

"Properly melted steel of the carbon used for products described in this paper contracts in volume when cooling, and, even after the exterior solidifies, the liquid interior still keeps contracting, and on solidification forms internal cavities called pipes. If the ingot mould be properly designed this piping occurs in the head, leaving the body of the ingot quite solid. There will be no blow-holes in the body of an ingot made of properly-melted steel of the class we are describing. If there are any, that particular ingot is unfit for use in high-class work for the walls of the blow-holes would not be welded together at the usual forging or rolling temperature. In dead soft steel there does not seem to be the same objection. An ingot free from blow-holes is the proof that the steel was properly melted. We have just seen, however, that if the head of the ingot be properly designed, so that it remains liquid longer than the body, it will contain the region of segregation and also the piping."

The views of Mr. Johns regarding the small value of fluid compression, while vigorously combated by some, were as strongly supported by others. There seems to be much reason in his position, since the fluid steel itself is doubtless as incompressible as water, and the only reduction in volume to be obtained is that of the blow-holes and voids. If the steel is properly melted these are not present and there is no gain to be secured. This fact is demonstrated by the fact that the specific gravity of fluid compressed steel is the same as that of well melted steel cast in open moulds as described by Mr. Johns.

In discussing the manufacture of tires the distinguishing feature is the development of the structure entirely during the operations of manufacture, no subsequent treatment being given. This involves the most careful selection of the materials, and the steel on analysis must show not more than 0.035 of phosphorus or sulphur. The temperatures giving the best results have been experimentally determined, and these temperatures are maintained by careful supervision during manufacture. The tires are allowed to cool in the air after leaving the rolls and receive no further heat treatment. An examination of the metal shows a well-marked sorbitic structure, which it would be difficult to improve.

In the case of axles the same general care must be exercised in respect of the purity of the metal, but the manufacture is followed by oil hardening at over 1,650 degrees F. Tabulated results of tests show a yield point of about 20 tons for an ultimate resistance of 35 to 38 tons, which is a relatively high elastic limit on a moderate ultimate stress, for a steel of 0.28 to 0.30 carbon.

In the case of shafts the only heat treatment given is that of annealing to relieve the strains set up during forging, no attempt being made to alter the structure.

"That form of thermal treatment known as 'oil hardening' is very interesting, owing to its having been adopted by ordnance manufacturers for a number of years. The author has no intention of dealing with the historical side of the question. Long experience has proved that the process gives the structure and special properties required for ordinance steel, and would also seem to indicate that it still remains the best method of obtaining the desired results. For ordnance work a steel having a high elastic limit is required. This could, of course, be secured by using a higher carbon steel, heating above the critical point and cooling in air, but we have already seen that the difficulty in making large forgings increases with the carbon. Gun tubes are heavy and difficult forgings, but their tubular form, with comparatively thin walls, lends itself to a thermal treatment, in which the rate of cooling is considerably accelerated, and the required tests can be obtained easily with a 0.30 carbon steel. The intelligent use of the results given by the chemical and physical tests, enabled the process to be successfully used in the past years, and now that more light has been thrown on the structural changes that take place in the steel itself, the methods adopted remain the same. The process is simple enough, though it requires a large plant when long forgings have to be treated. They are raised to a temperature well above the critical range, quickly immersed in oil and allowed to cool. They afterwards are heated to 1,100 degrees F. and allowed to cool slowly. In practice it is better to re-heat the forgings up to 1,100 degrees F. than to stop the rapid cooling at the same point and then to cool slowly. If the forging warps or twists, it is rectified, and is then ready for the final machining. The effect of the treatment is to cause a sudden segregation of the carbide of iron, not into the sharply-marked crystals of pearlite as in annealed steel, but into more indefinite areas of sorbitic pearlite. These areas are more diffused than would be the case with the pearlite of annealed steel, and would retain some of the hardening carbon, hence the raising of the elastic limit of the steel. It would also appear that the cohesion between the ferrite and sorbitic pearlite is greater than with ferrite and pearlite, probably owing to the line of demarcation being less strongly marked. In any case the steel so treated has a comparatively small grain, gives a high elastic limit with a good percentage of elongation. That these results can be obtained from a steel sufficiently low in carbon to be worked in large masses constitutes the great value of the process to the ordnance manufacturer."

BLAST-FURNACE EFFICIENCY.

THE THERMAL EFFICIENCY OF THE BLAST FURNACE CONSIDERED AS AN APPARATUS FOR THE CONVERSION OF HEAT ENERGY.

W. J. Foster—Iron and Steel Institute.

SEVERAL years ago we referred in these columns to the investigations of M. Rocour, of Liége, upon the heat balance of the blast furnace, taking the total amount of heat delivered by the fuel and the hot blast, and balancing against this the amount required to accomplish the reactions produced in the reduction of the iron from the ore. According to the computations thus made, it appeared, from a comparison of data from Belgian, German, British, and American furnaces, that the thermal efficiencies ranged from 52 to 66 per cent., or, in other words, that about two-thirds of the heat supplied was actually utilized in the production of iron.

At the recent meeting of the Iron and Steel Institute this subject was further considered in the paper presented by Mr. W. J. Foster, furnishing additional data, and, in great measure confirming the results of the researches of M. Rocour.

Mr. Foster discusses at length the influence of the hot blast, and shows that further experimental study is necessary in order that the full action of the heat in the blast may be fully understood. He then proceeds to compute the calories required for the various reductions taking place in the furnace, these being tabulated very fully in the original paper, to which the reader is referred. In general we may note that of the entire quantity of heat supplied about 22 per cent. is utilized in the reduction of iron oxide, while nearly 60 per cent. is discharged as combustible gases, the remainder being used in the reduction of silica, phosphorus, sulphur, manganese, etc., and expended in the fusion of slag, in the decomposition of the vapor of water, in driving off the bonic acid from the flux, and in the various losses, such as radiation, in the tuyere-cooling water, etc. This shows the correctness of the position which regards the blast furnace as a great gas producer, and indicates the importance of the industrial utilization of the gases which represent more than half of the heat energy supplied.

Mr. Foster proceeds to investigate the conditions which may conduce to an improvement in blast-furnace efficiency, giving especial attention to the results of rapid driving, and an increase in the temperature of the blast. It may not at first appear that the increase in the temperature of the blast can produce an increase in efficiency, since this implies an increase in the temperature of the hearth and the tuyeres.

"By increasing the temperature of the hearth, however, less blast per unit of iron made is required, for the reason that the oxides that are endothermic under ordinary conditions are converted into exothermic bodies, which is in part due to the heat absorbed by the materials on their descent to the hearth, with the result that a great amount of carbon is gasified in the hearth and bosh from the oxygen from these bodies, and, therefore, less nitrogen per unit of oxygen would be present in the furnace gases, and also a less quantity of water vapour would have to be decomposed at the tuyeres. By this it will also be seen that less gas per unit of material entering the furnace will be required, which simply means a larger quantity of cold materials entering the mouth, with a corresponding reduction of gases; this, of course, will readily explain the reason for a reduction in the temperature of the escaping gases.

"Then comes the question of a reduction of the temperature in the gases due to rapid driving. This can be explained in a similar manner to the hot blast question, only in this case we can account for the extra heat accumulated in the hearth as due to less heat per unit of iron being lost by radiation; or, in other words, extra heat is absorbed by the descending materials that would otherwise be lost by slow driving with an increased loss by radiation, etc., which will hereafter be more particularly described when dealing with the reducing zone of the ordinary furnace. Now comes that very important question of combustible matter in the gases, which represents more than half of the fuel. This particular question opens out a very large field for future research in thermo-chemistry, which will obviously, when thoroughly understood, lead to great economy in fuel consumption of blast furnace practice; nevertheless, from a practical point of view, it appears that rapid driving increases the quantity of carbonic acid gas in the gases when leaving the furnace, which points to the fact that a rapid transfer from the reducing zone to the hearth, of the reduced iron and other materials, would result in economy in this direction, on condition that the carbon and fluxes, etc., are heated sufficiently before approaching the hearth.

"It will clearly be seen that once we can account for a saving of fuel in one particular case, there will be established a foundation that will lead to economy in every other part of the system, other than those cases previously mentioned. From time to time many authors have attempted to explain theoretically the reason why a charcoal furnace has more carbonic acid gas in the gases, and at the same time a reduction of temperature, as compared with the ordinary coke furnace, but up to the present they have not arrived at a satisfactory solution, chiefly owing to the fact that charcoal is more readily attacked by carbonic acid than coke would be. In the blast furnace we are confronted with that important question known to themal chemists as the influence of mass, and this is the question to my mind that will greatly assist us to decide the great difference between charcoal and coke furnaces. At a first glance it might be suggested, owing to the excessive volume occupied in the charcoal furnace by the fuel, that this would increase the possibility of dissolving the carbonic acid into carbon-monoxide, but, of course, we must take into consideration the properties of other materials. For example, we must consider the two very important reactions that take place in the reducing zone, namely, the reduction of iron oxides, and the splitting up of carbon monoxide by metallic iron as previously mentioned; both reactions, which are highly exothermic, develop a great amount of heat during the chemical changes. In the charcoal furnace it will be seen that the quantity of oxides of iron present in proportion to the gases is very small as compared with that of the coke furnace, owing to the excessive volume occupied by the charcoal, consequently less heat is evolved in a given quantity of matter, so that we have a less chance of bringing the temperature of the reducing zone to that point which would decompose the carbonic acid gas generated, owing to the fact that the decomposition of CO_2 on solid carbon or metallic iron is accompanied by absorption of heat, which indicates that any of these changes could only take place with the introduction of excess of external heat to the system."

That the more rapid working will conduce to increased efficiency seems to be accepted, both in theory and in the practice of the larger furnaces now so generally used in the United States.

Thus, it appears that the diminution in losses due to radiation alone would, by sextupling the speed of working, give an economy in fuel of 10 per cent., while the gain due to more efficient combustion, as indicated above, is also marked.

The scientific study of blast furnace operation, and the application of the heat balance to account for the distribution of the energy in the fuel seems sure to yield most valuable results, and it will doubtless be given increasing application in practice hereafter with corresponding influence upon technical and commercial performance.

REFRIGERATOR FREIGHT CARS.

THE SUBSTITUTION OF PORTABLE REFRIGERATING MACHINERY FOR ICE IN THE TRANSPORTATION OF PERISHABLE FREIGHT.

Warren H. Miller—Stevens Institute Indicator.

REFRIGERATION as a means of preserving perishable freight has been employed for a number of years in the United States, and the long distances over which fruit and similar products, as well as other food stuffs, are carried bears witness to the importance of the refrigerator car. By its means the products of the warmer portions of the country, as Florida or California, are transported to great cities of the Atlantic coast, enabling a continual supply to be maintained, and sustaining a great and increasing industry.

The usual method of constructing refrigerator cars has been based upon the employment of ice as a means of cooling. This limits the distance, or rather the time, of transport to the practicable conditions dependent upon the amount of ice to be carried, and upon the cost. Under such circumstances it is not surprising that attempts should be made to adapt mechanical refrigerating processes to this service, and to design a portable refrigerating machine to form a part of the car. Such an apparatus has been put into successful use in several parts of the country, and from a paper by Mr. Warren H. Miller, in a recent issue of the *Stevens Indicator* we extract some account of the construction and operation of the equipment.

A refrigerating machine consists essentially of a compressor, circulating pipes, and a condenser, the medium used being some one of several gases. When such a system is applied to a car the compressor may be driven from the axle, the circulating coils cooling the car, and the condenser abstracting the heat from the compressed gas. These seem like simple operations, but the limitations involved in their application to freight car service, and the necessity for making an apparatus which shall be absolutely independent of attention while on the road, have made the problem one of no small difficulty.

In stationary ice machines the condenser coils can be cooled by a constant supply of water, but on a freight car the limitations to the amount of water which can be carried make the condenser design one of the important elements. The principle adopted is that which has also been used of late for steam-engine condensers in localities where the water-supply is limited, the evaporative principle being employed. Theoretically a given amount of water evaporating from the outside of a pipe should be able to condense an equal amount of water within, assuming that no heat is supplied from any other source. In practice such a result cannot be attained, but the reduction in the amount of water required by use of the evaporative principle has been found to be sufficient to make the operation entirely practicable on a travelling freight car. In practice Mr. Miller states that about 200 pounds of water are required per ton of refrigeration, which has proved satisfactory.

The ice machine used in the system described by Mr. Miller is of the carbon dioxide type, and is mounted in an enclosed casing suspended beneath the car, the compressor being driven by gearing from the axle. By using an oil seal to the stuffing box the leakage is prevented, and the whole apparatus made independent of any attention except at the ends of the runs. A machine of a capacity of 1¼ tons of ice in 24 hours requires 1.3 horse-power, corresponding to about 35 pounds resistance on the rim of the car wheel.

In order to provide for the cooling at starting a certain amount of ice must be carried at first, and this is afterwards replaced by the frost which forms of the cooling coils, so that the car may remain standing for some time without risk.

"As regards care and maintenance, the only thing which requires renewal is the condenser water. There is provision for replenishing the water supply from engine hydrants, but in practice a car does well that makes two Chicago-New York trips per month, or its equivalent. Rain shed from the roof invariably fills the condenser tank to overflowing, sometimes as often as four times a week, and it is rare that a car has to be taken to a locomotive hydrant to be filled. Oil requires renewal about once in eight months, and an extra drum of carbonic acid gas must be put in once in three months."

Practical experience with these cars has been such as to show that their use in regular service is altogether possible, and the cost of operation is necessarily much lower than that of the ordinary refrigerator cars using ice alone. The cost of the power is small, and it can be shown to be more than counterbalanced by the increase in capacity of the cars for merchandise, owing to the reduction in the space required for ice, while the allowance for repairs and depreciation, while yet to be determined by experience, cannot be great with such a simple apparatus. Doubtless extended experience will result in improvements in the machinery, and its use upon various railroads in the United States will determine whether this more scientific method will replace the older and cruder, as well as more expensive plan of carrying sufficient ice to last the entire trip.

IMPROVED TOOL STEELS.

EXPERIENCE IN THE RAILROAD SHOP SHOWING RELATIONS BETWEEN STEELS, MOTORS DRIVING, AND MACHINE TOOLS.

W. R. McKeen—Railway Master Mechanics' Association.

ABOUT a year ago we reviewed in the pages some of the results which had been attained in the shops of the Union Pacific Railroad Company at Omaha, and now we have a very full and valuable account of practical investigations made in the same works by Mr. W. R. McKeen, the Superintendent of Motive Power, and presented at the Saratoga meeting of the American Railway Master Mechanics' Association.

The value and importance of the tests lies largely in the fact that they represent actual practical work in the railway shop. "The tests were not made on specially devised castings or forgings, nor were any machines arranged in special reference to these tests. All observations were made on work going through the shop during regular working hours and on actual locomotive parts being put through the shop; these same parts being afterward applied to locomotives. The tests were conducted according to the directions of the chemist and engineer of tests, and under the supervision of the general shop demonstrator; the electrical readings were taken by the local electrician, and the machines were handled in their regular course by the mechanics assigned to each class of work. Turning and planing tools were forged and tempered by the regular toolsmith, and the twist drill and milling cutters were made in the local toolroom. Under these conditions a much fairer comparison as to the actual benefits obtained from alloy tool steel in regular shop practice can be made than where special test conditions are followed."

Three lines of comparison were taken, namely: First, the speed, cut and feed; second, the durability of the tools; third, the amount of power expended in keeping a tool up to its proper capacity. The first depends upon the volume of output; the second on the quality of steel and manufacturer's and toolmaker's skill; the third being closely related to the first and dependent on it.

Mr. McKeen rightly calls attention to the fact that air-hardening steels have been in the field for a long time, and that these, although by no means the equal of the modern high-speed steels, are superior to the older carbon steels. He well remarks that the ordinary air hardening tools may be considered as holding a position midway between the old carbon steels and the new high-speed alloy steels. The comparisons made in the paper, however, are between the old carbon steels and the modern high-speed alloy steels, leaving the ordinary air-hardening steels out of consideration.

The tests made in the Union Pacific Shops at Omaha consisted in comparative trials made between the two kinds of tools upon the operations of planing, lathe work, milling, and drilling. The results of the trials are tabulated in the paper, but we give here some account of the conditions of the tests, with a general summary of the results.

The planing tests consisted in roughing out side rods of soft steel, the data taken being the amount of metal removed and the time required for actually removing the metal, not including the time used in setting work nor in the reverse travel of the planer.

Apart from the far greater efficiency of the new steel, as shown in the summary, it may be noted that the alloy tool kept its edge throughout the tests, and was in condition to do two or three hours more work without regrinding. Regrinding is found to be required, not because the cutting edge is destroyed, but from the hollowing out of the top of the nose of the tool by the surface friction of the metal removed. Any attempt to use carbon steel at the same speed showed the impossibility of doing so, the cutting edge being completely burnt off at the end of three-quarters of a minute, the nose of the tool being destroyed for half an inch, making any further cutting impossible. In order to maintain a cutting edge it has been found necessary to maintain only about one-half the depth of cut practicable with the alloy steel. Corresponding results were obtained with the other operations, both as to the amount of metal removed and the power required to perform the machining operations.

Apart from the gain in the actual machining operations, Mr. McKeen calls attention to the saving effected in the one matter of tool grinding. In the case of the carbon-steel tool the operation of regrinding had to be performed three times for each tire turned, this operation requiring fifteen minutes each time, counting the time walking to and from the emery wheel; while the high-speed steel tool lasts through the entire job with but a single grinding, a gain in time directly due to the steel, in addition to the higher speed of the actual operation of turning.

A summary of the tests follows:

Planer Tests.—Alloy steel necessitated 20.9 horse-power removing 780 lbs. of metal per hr., as against 15.9 horse-power with carbon steel and only 288 lbs. metal removed per hour.

Wheel Lathe Tests.—Alloy steel necessitated 6.5 horse-power with 96 lbs. metal removed, as against 2.3 horse-power with carbon steel and 15 lbs. metal removed.

Lathe Tests (Cylinder Bushing).—Alloy steel necessitated 11.6 horse-power and 180 lbs. of metal removed, as against 10 horse-power with carbon steel and 54 lbs. metal removed.

Milling Machine Tests (Locomotive Shoe).—Alloy steel necessitated 4.4 horse-power and 195 lbs. metal removed, as against 3.1 horse-power with carbon steel and 82 lbs. metal removed.

Radial Drill Tests (Cast Iron Blocks).—Alloy steel necessitated 5.6 horse-power and 88 lbs. metal removed, as against 2.6 horse-power with carbon steel and 51 lbs. metal removed.

"Improved, or alloy, tool steel has increased the output of railroad shop machines from 25 per cent. to 100 per cent., and in certain cases as much as 200 per cent., and while, with increased output, the horse-power required to turn out work has increased, this increase of horse-power absorbed is not in proportion to the increase in output. The use of alloy steel, where machines have been driven by motors already worked up to capacity, will necessitate 25 per cent. to 50 per cent. larger motors, as has ben evidenced by our own experience.

"The strength and capacity of our present machines are almost universally overtaxed, for the reason that they were not designed for the new conditions. Our experience has shown conclusively the necessity for heavier and more substantial design of all machines; steel pinions instead of cast iron; longer bearings for shafts and increased diameter. Furthermore, it clearly demonstrates the economy of scrapping old-style machinery.

"Our best record on locomotive driving wheels is a 56-in. pair in 1 hr. and 27 mins. Steel-tired car wheels formerly required from 5 hours up to turn and true to size; the present minimum time in our shops is 55 minutes, the average being about two hours. While these reductions in time are largely due to the alloy steel, improved shop methods and system have also entered largely into the economies mentioned."

It is this last feature, namely, the additional shop economies which follow in the wake of the introduction of the new tool steels which constitute a most important feature of the whole movement.

It has been shown that the actual time occupied in machining even a complicated piece forms but a small proportion of its time in passing through the shop. With the introduction of the rapid gait on the machine tools themselves, however, the pace is accelerated all along the line. In the modern shop the old time deliberate movements are conspicuous by their absence, and a new spirit of life and activity appears on all sides. In a large number of cases the men at the tools are working under some form of piece or premium wage system, and they soon find that their output, while largely increased by the use of the rapid-cutting tool is also dependent to a great extent upon the promptness with which they are served. Any dawdling either with laborers, cranes, or other handling appliances is quickly detected by them, and it has often been found that with the improved tools and methods it is necessary to reorganize the entire system of handling materials in order that the machine tools may be kept supplied with work.

Such tests and records as have been made by Mr. McKeen are most valuable and interesting, but it would also be most desirable to have data as to the total gain in product due to the introduction of the new steels, including the increase due to the more rapid pace of the establishment.

ENGINEERING AND THE FOUNDRY.

THE RELATION OF THE FOUNDRY TO THE WORK OF VARIOUS DEPARTMENTS OF ENGINEERING PRACTICE.

Dr. R. Moldenke—American Foundrymen's Association.

CAST IRON has had various ups and downs as a material of engineering construction, and having fallen from its once high estate it has again be rehabilitated to a great extent by the application of scientific principles to its production and use. We do not expect to see cast-iron shafting, nor is it probable that cast iron will be again used for bridge construction, but the intelligent application of that kind of engineering which Nasmyth defined as "common sense applied to the use of materials" is undoubtedly being given to the foundry and its products. In a paper presented at a recent meeting of the American Foundrymen's Association by Dr. Richard Moldenke the relation of the foundry to various departments of engineering work is discussed in a very satisfactory manner, and some abstract of the paper is here given:

"It is not so very long ago that when an engineer had to do some detailing in which cast iron was used, he simply figured on a strength of 10,000 pounds per square inch, and let it go at that. To-day more is required of a man up in his profession. Where the use of cast iron is advantageous, it makes quite a difference whether ordinary cupola metal is employed or the highest grade gun metal. In other words, the engineer should know something of the several kinds of cast iron made, how they are made and how used to the best advantage.

"The best indication of this modern tendency is seen in the recent presentation of specifications for testing cast iron and finished castings. These arose from the demand of the buyer to know what he is paying for, and as a consequence he is learning to specify his wants more clearly. Then also there is the desire of the engineer to acquaint himself with a material he is called upon to inspect for the buyer, and pass upon as good for the purpose or not. Finally, the foundryman himself, in his most broad-minded form, has always been desirous of giving the customer the best he can make, and indeed must do this or find his product replaced by the malleable or steel casting. All these tendencies have brought about a general getting together of those most interested, with the result that for the first time in the history of the iron industry has a common ground been found for working specifications governing the testing of cast iron and its products."

Dr. Moldenke examines the extent to which engineers in different departments of work need to be informed upon the various properties of cast iron and its different applications.

"It will be easily seen how the civil engineer will be specially interested in cast iron going into railroad and bridge construction, whether for actual working parts or merely the ornamental end. Similarly in the designs of buildings, whether terminals or skyscrapers. The mechanical engineer naturally has more to do with cast iron and runs through the whole gamut in his daily practice. In the railroad service he deals with malleable as well as gray iron castings in his car construction. The locomotive adds some steel castings to these. Then the cast iron car wheel will give him enough to think of, as will be seen from the specifications alone. In the machine shop, rolling mill and in the foundry itself, the mechanical engineer should be a master in adapting this metal, in its various forms, to the purpose in hand, and hence he cannot learn too much of the production of all classes of castings, gray, chilled, malleable and steel.

"Finally there is the mining engineer, who has probably to suffer most from breakdowns with iron castings, as he is always isolated and must transport his repair parts great distances. He also should know something of foundry practice, as he could oftentimes help himself by "burning on" a broken piece, if he but knew how to rig up a temporary cupola out of an old boiler shell, and drive compressed air into the charge."

In making specifications for cast iron the engineer has to consider both pig iron and foundry castings, and these should be considered separately. The grading of the pig iron is based upon the content of silicon and sulphur, the best grades having the most silicon and the least sulphur, the ferro-silicons forming a class by themselves. It does not follow that a low-grade pig should be rejected, since the volume may be proportionally adjusted and the material suitably improved by mixing.

The character of castings may be graded by a suitable application of correct methods of testing.

"This is the result of years of thought and experiment by engineers' and foundrymen's associations, as well as independent investigators, thoroughly digested by those who were most active in this work, and the result approved by a majority of the cast-iron experts of the country. The following principles were recognized: In America we prefer to judge a casting which cannot be tested to destruction, by the quality of the iron entering into it. That is to say, by pouring the melted iron into test bars, under standard conditions, and then testing these bars to form conclusions therefrom. Next it is recognized that these bars should be made of as large a section as possible, consistent with a proper structure, or constitution of the iron, to avoid the artificial influences of damp molding sand, variations in pouring temperature, cooling strains, etc. Also to keep the tests within the limits of the ordinary testing machines found in our foundries.

"Then comes the cross-section of the bars, the round form being better than the rectangular, as it avoids the artificial cooling at the corners. Next the manner of casting. Experience has shown that a bar cast flat, when tested in the position as cast gives different results from those obtained when the bar is reversed. Hence the importance of casting the bars vertical. The refinement of the bottom pour, though giving better results, is too cumbersome for commercial use. A suitable rotation in the casting of these bars is necessary, so that the results may be representative. The bars are not to be tumbled, as this would remove casting strains, and make the material artificially strong when compared with the castings themselves, which are not so treated. Finally comes the testing of the bars themselves, which experience has shown to be best accomplished by placing them upon supports 12 inches apart and breaking by applying the load at the center. The deflection is also noted."

Wherever there is a quiescent load. which requires a material with high crushing strength to sustain it, there cast iron will be found most valuable. Wherever art constructions of the engineer, there cast iron is essential. The fact that last year some 3,600,000 tons of castings were made in America shows what this industry means to the engineering and building work of the United States.

THE ENGINEERING INDEX

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IN THE ARCH OF APPLIED SCIENCE"

The following pages form a DESCRIPTIVE index to the important articles of permanent value published currently in about two hundred of the leading engineering journals of the world—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every article.

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(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published.

We supply the articles themselves, if desired.

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer and works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of any article referred to in the Index, together with all illustrations, can usually be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the journals indexed are given.

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CIVIL ENGINEERING

BRIDGES.

Approaches.

The Mingo Bridge Approaches. This bridge carries a double-track railroad across the Ohio River near Mingo Island. Begins an illustrated detailed description of the construction work. 2200 w. Eng Rec—June 25, 1904. Serial. 1st part. No. 63555.

Arch.

The Luxembourg Bridge (Le Pont de Luxembourg). R. Bonnin. A well illustrated account of the construction of the great twin masonry arch of 84.65 metres span at Luxembourg. 3000 w. Revue Technique—May 25, 1904. No. 63231 D.

Articulations.

Articulations in Granite for Bridges. Describes methods successfully carried out in Wurtemberg and Saxony in which articulations of a metallic character are excluded and the same purpose accomplished by means of arch stones or concrete voussoirs in direct contact with one another. 1100 w. Engr, Lond—June 10, 1904. No. 63441 A.

Bascule.

A Short-Span Bascule Bridge in New York City. Brief illustrated description of the bridge over the Mott Haven Canal at 135th street. 800 w. Eng Rec—June 18, 1904. No. 63421.

Design.

The Detailed Design of a Railroad Bridge. William H. Burr and Myron S. Falk. An exposition of the design of a steel railroad truss bridge showing the application of engineering science in this field. Ills. 9000 w. Sch of Mines Qr—April, 1904. No. 63338 D.

Girder.

A Three-Track Beam-Floor Girder Bridge. Illustrates and describes the principal structural pecularities of a bridge in Newark, N. J. 1300 w. Eng Rec—June 18, 1904. No. 63420.

Railway Bridge.

Railway Bridge Over the Clyde at Uddington. Two-page plate and illustrated description of a new bridge for carrying the Caledonian main line of railway between Glasgow and Carlisle. 1700 w. Engng—June 17, 1904. No. 63497 A.

Substructure.

The Substructure of the Fraser River Bridge. Illustrates and describes the substructure of this bridge in British Columbia, and its construction. 3300 w. Eng Rec—May 28, 1904. No. 63048.

Suspension.

Conway Suspension Bridge. An account of the reconstruction of this historic bridge in Wales, designed by Telford nearly eighty years ago. 1800 w. Engr, Lond—May 20, 1904. No. 63017 A.

Vauxhall.

The New Vauxhall Bridge. Reviews the history of the rebuilding of this bridge and the cause of the delay. Ills. 4700 w. Engng Rev—June, 1904. No. 63539 B.

Viaduct.

The Viaur Viaduct. Daniel Bellet. Illustrated detailed description of this viaduct in the south of France. It has a total length of 1,509 feet; the central arch a span of 721 feet 9 inches; the rails are at height of 377 feet above the river. 4000 w. Trac & Trans—June, 1904. No. 63377 E.

Woodsville.

The Woodsville Railroad and Highway Bridge. Illustrates and describes this bridge across the Connecticut River which is the sixth built at this point. 2500 w. Eng Rec—June 25, 1904. No. 63557.

CONSTRUCTION.

Domes.

Notes on the Stresses in Framed Spires and Domes. W. Dunn. An explanation of the method of determining the nature of the stresses, giving stress diagrams. 7500 w. Jour R Inst of Brit Archts—May 21, 1904. No. 63382 B.

Fire Protection.

Necessary Reforms in the Fire Protection of Theatres (Ueber die Feuersicherheit der Theater und die Notwendigen Reformen). Hermann Helmer. With plans of a number of existing structures, and suggestions for an improved design. 5000 w. 1 plate. Zeitschr d Oesterr Ing u Arch Ver—May 20, 1904. No. 63237 D.

Some Lessons of the Baltimore Conflagration. The principal part of a report submitted to the Insurance Engineering Experiment Station by Prof. C. L. Norton and Joseph P. Gray. 2500 w. Eng News—June 2, 1904. No. 63084.

Platform.

Arch Trusses for Aerial Circus Platform. Gives plans and details of arch trusses for aerial circus at Luna Park, Coney Island, New York. 1100 w. Eng Rec—June 18, 1904. No. 63422.

Reinforced Concrete.

A Factory Building with Reinforced Concrete Wall Girders. Illustrated description of construction work at Passaic, N. J. 1300 w. Eng Rec—June 18, 1904. No. 63423.

A French Breaking Test of Reinforced Concrete Bridge Trusses. Leon S. Moisseiff. Describes the construction and breaking test of the bridge built by the Paris-Orleans Ry. Co. for this purpose. Ills. 4000 w. Eng Rec—June 4, 1904. No. 63101.

An All-concrete Grand-Stand. Illustrated detailed description of the recently completed grand-stand for the athletic field at Washington University, St. Louis. 1000 w. Eng Rec—May 28, 1904. No. 63047.

A Reinforced Concrete Store Building in Chicago. Illustrated detailed description of the construction of a seven-story building. 1200 w. Eng Rec—June 4, 1904. No. 63103.

Concrete Steel Construction. Leonard C. Wason. Abstract of a lecture before the Civ. Eng. Soc. of W. P. I. Information concerning cements and their manufacture, their strength, elasticity, &c., with points in construction work, showing that concrete steel is an economical and durable material. Ills. 3300 w. Jour Worcester Poly Inst—May, 1904. No. 63316 C.

Design for Reinforced Concrete Bins for Grain Elevators. Illustrated description of a rectangular bin construction with supporting columns. 1500 w. Eng News—June 23, 1904. No. 63486.

Reinforced Concrete in Building Construction. Condensed from a paper read by Emile G. Perrot before the School of Architecture, University of Pennsylvania. Considers various important questions in regard to its reliability, its advantages, &c. 2800 w. Eng Rec—May 28, 1904. No. 63045.

Reinforced Concrete Piles with Enlarged Footings for Underpinning a Building. J. Albert Holmes. A brief description of work in Boston, underpinning exterior walls of a building erected on filled land. Ills. 500 w. Eng News—June 16, 1904. No. 63406.

Some Phenomena of the Adhesion of Steel and Concrete. J. W. Schaub. Extract from a lecture on "Reinforced Concrete" delivered at Armour Institute, Chicago. Gives results of experimental investigations. 1300 w. Eng News—June 16, 1904. No. 63405.

Roofs.

Developing the Surface of Spherical Roofs by Calculation. Jas. Clark. Describes the method used by the writer. 700 w. Am Mach—June 23, 1904. No. 63510.

Roof Trusses.

A Novel Method of Erecting the Roof Trusses of the 71st Regiment Armory, New York City. W. T. McCarthy. Illustrates and describes an economical and novel method of erecting a riveted truss of long span. 1500 w. Eng News—June 16, 1904—No. 63404.

Tunnels.

Italo-Swiss Alpine Tunnels. Outlines the various schemes proposed and under construction for connecting Italy and Switzerland, and tunneling the Alps and Apennines. 1800 w. Engr, Lond—June 10, 1904. No. 63437 A.

Notes on the Early History of the Hudson River Tunnel. S. D. V. Burr. An account of early work on this tunnel, describing also some of the peculiar physical characteristics of the silt composing the bed of the river. 1800 w. R R Gaz—June 3, 1904. No. 63107.

The Hudson River Tunnel. S. D. V. Burr. An illustrated article comparing the original methods with those now employed. 3000 w. Ir Age—June 2, 1904. Serial. 1st part. No. 63058.

MATERIALS OF CONSTRUCTION.

Cement Plant.

Cost of Building and Operating a Portland Cement Plant. Considers things that cause variation in the cost, and gives information concerning a mill with an output of 2000 barrels per day. 3000 w. Munic Engng—June, 1904. No. 63323 C.

Efficiency of Rotary Cement Kilns. Dr. W. Michaëlis, Jr. Illustration, with description of a patent of the writer's for increasing the capacity of a rotary kiln under the wet process. 1600 w. Eng Rec—June 4, 1904. No. 63104.

Cement.

Standard Specifications for Cement. Gives the specifications ordered sent out for approval by the Am. Soc. for Testing Materials. 1100 w. Eng Rec—June 25, 1904. No. 63556.

Tests of Cements. J. E. Howard. Begins an account of the tests made at the Watertown Arsenal. 3300 w. Am Archt —June 18, 1904. Serial. 1st part. No. 63445.

Concrete.

The Quality and Consistency of Concrete for Concrete-Steel Work. Editorial discussion of the importance of excellence of materials and manufacture in this work and the proper composition, and the practical advantages of wet mixtures. 1600 w. Eng News—June 9, 1904. No. 63180.

Concrete Blocks.

Concrete Block Manufacture. Considers the underlying principles which should govern the development of this industry. 1800 w. Munic Engng—June, 1904. No. 63322 C.

Concrete Mixer.

Concrete Mixer with Automatic Measuring Device. Illustrated detailed description of an invention of Henry Campbell, of Milwaukee, Wis. 1500 w. Eng News —June 2, 1904. No. 63083.

Nails.

A New Form of Nail (Un Nouveau Clou). R. Wittebolle. A comparison of the weak features of various forms of nails, showing the advantages of a special form of chisel point. 2500 w. Revue Technique—May 25, 1904. No. 63232 D.

Plaster.

The Setting of Plaster of Paris (Etude des Conditions de Prise du Platre). Louis Périn. A description of the "Prisometre" devised by the writer to determine the rate of setting of plaster. 1000 w. Génie Civil—June 4, 1904. No. 63229 D.

Stone Working.

Stone-Working Machinery. Illustrated description of a new type of machine for surfacing stone; especially adapted for granite. 800 w. Engr, Lond—June 10, 1904. No. 63442 A.

MEASUREMENT.

Surveys.

Hydrographical Surveys, 1903. Reviews the chief points of interest in connection with the operations of the British surveying vessels. 2500 w. Engr, Lond—May 27, 1904. No. 63131 A.

Topography.

The Use of Stereoscopic Images for the Construction of Topographic Plans (Sur l'Emploi d'Images Stéréoscopiques dans les Construction des Plans Topographiques). A. Laussedat. Describing a system of exaggerated stereoscopic photography for use in photographic surveying. 2000 w. Comptes Rendus—May 30, 1904. No. 63256 D.

MUNICIPAL.

Baltimore.

Progress of Plans and Work for Rebuilding Baltimore. Daniel J. Hauer. Gives a general synopsis of the lines on which the city is to be rebuilt, showing the progress. Map. 2400 w. Eng News—June 2, 1904. No. 63078.

Pavements.

Neglected Details in Brick Pavement Construction. Ira O. Baker. Read before the N. B. M. A. Convention. Discussses the width of pavement, subgrade, foundations, cushion, brick, and joint filler. 5000 w. Brick—June, 1904. No. 63481.

Refuse.

Refuse Destruction by Burning, and the Utilization of Heat Generated. C. Newton Russell. Treats the practical side of the question, describing the works with which the writer is associated. Ills. 4800 w. Inst of Mech Engrs—June, 1904. No. 63332 D.

The Burning of Town Refuse. George Watson. With special reference to the destructors at Brussels, West Hartlepool, Moss Side, and Westminster. Ills. 9000 w Inst of Mech Engrs—June, 1904. No. 63332 D.

Roadways.

Roadways: Their Relationship to the Various Public Services. A. E. Broadberry. Read before the Inst. of Gas Engrs. Suggestions for an organized arrangement of roadways in their relation to sewers, surface drainage, water and gas supply, telephones, &c. General discussion. 4500 w. Gas Wld—June 11, 1904. No. 63495 A.

Sewage Disposal.

Adaptability of the Massachusetts Method of Intermittent Sand Filtration to Sewage Disposal Problems in Other States. F. Herbert Snow. Discusses the part the Massachusetts State Board of Health has taken in placing the art of sewage disposal on a scientific basis, and considers four typical problems outside of the State. Discussion, including also Mr. Goodnough's paper. 11000 w. Jour Assn of Engng Soc's—May, 1904. No. 63394 C.

A Description of Sewage Disposal Systems in Massachusetts. X. Henry Goodnough. Reviews the progress of sewage disposal in the State, and gives brief illustrated description of the more important plants. 4700 w. Jour Assn of Engng Soc's—May, 1904. No. 63393 C.

New Sewage Works at Glasgow. Illustration, with description of some of the interesting features of this plant, which is the second largest in the world. 2000 w. Engr, Lond—June 3, 1904. No. 63372 A.

Sewage Disposal. Prof. W. S. Leavenworth. Reviews the various methods in use. 4500 w. Dom Engng—May 25, 1904. No. 63018 C.

The Use of the Septic Tank in Connection with Sewage Disposal Works. Frank A. Barbour, with discussion. Refers to several plants, and concludes that facts justify the further use of this system. 18000 w. Jour Assn of Engng Soc's—May, 1904. No. 63395 C.

Sewerage.

Extensions of the Brooklyn Sewerage System; Foster Avenue Trunk Sewer. Describes two sections extending eastward from the Sixtieth street sewer. 2400 w. Eng Rec—May 28, 1904. No. 63049.

The Scheme of the Extensions of the Brooklyn Sewerage System. Map, with a statement of the general scheme, based upon the report of the chief engineer. 3300 w. Eng Rec—June 11, 1904. No. 63189.

Streets.

The Streets and Street Plan of Paris; A Lesson in Municipal Esthetics. Remarks on the beauty of Paris, comparing London, New York and Washington. 2000 w. Eng News—June 2. 1904. No. 63082.

Waste.

The Utilization and Disposal of Municipal Waste. William F. Morse. Considers the disposition of garbage, ashes, refuse and street sweepings in large cities. Ills. 5200 w. Jour Fr Inst—June, 1904. No. 63340 D.

WATER SUPPLY.

Analysis.

Methods and Interpretation of Water Analysis. A. Robin. Shows the unreliability of chemical analysis alone, considers the bacteriological examination, and that a proper combination of laboratory methods is needed for an accurate conclusion to be reached. 4800 w. San—June, 1904. No. 63154 D.

Antwerp.

The Antwerp Water Works. An illustrated detailed description with history of the water supply of this important port.

3000 w. Engng—May 27, 1904. Serial. 1st part. No. 63127 A.

Aqueducts.

Repairs and Reconstruction on the Old Croton Aqueduct. Describes this aqueduct which was put into service in 1842, reviewing the repairs made at different times, and those now being made to enable it to resist an external pressure of twenty pounds per square inch. 3000 w. Eng Rec—June 18, 1904. No. 63417.

Baden.

The Water Supply and Sewerage of Baden (Die Wasserleitung und Kanalisation von Baden). Thomas Hofer. A detailed account of the new water supply of Baden, Austria, and of the recently constructed drainage system. Two articles, two plates. 8000 w. Zeitschr d Oesterr Ing u Arch Ver—May 27, June 3, 1904. No. 63237 each D.

Derwent Valley.

Quarries and Works of the Derwent Valley Water Board. Illustrated description of one of the largest schemes for water supply in England, which is to serve the towns of Leicester, Derby, Sheffield and Nottingham. 3300 w. Quarry—June, 1904. No. 63359 A.

Filtration.

Concrete Work on the Washington Filtration Plant. E. D. Hardy. An illustrated description of the work of placing the concrete masonry. 1200 w. Eng Rec—June 25, 1904. No. 63554.

Fire Service.

Water Service at the Baltimore Fire. Extracts from a paper before the Am. Water Works Ass'n, by Alfred M. Quick. Describes the distribution system in Baltimore, and discusses whether any water service could successfully cope with such an emergency, the effectiveness of private fire services, and the possibility of the waste in buildings destroyed by the fire temporarily crippling the service. 5000 w. Eng Rec—June 11, 1904. No. 63187.

Irrigation.

Government-Irrigation Work. Guy E. Mitchell. An illustrated article describing proposed work, for which $2,600,000 have been appropriated. 1200 w. Sci Am Sup —June 11, 1904. No. 63306.

Meters.

Effect of Meters, New Storage Reservoir and Yield of Watershed, Newark Water Works. Statement and diagram from the report of M. R. Sherrerd, showing the influence of the compulsory introduction of about 4000 meters. Also information concerning the new Cedar Grove reservoir, and the development of the watershed. 2000 w. Eng Rec—June 11, 1904. No. 63191.

Test of a 30-inch Premier Meter at the Testing Plant of the National Meter Co., Arthur S. Tuttle. Description of the test, with illustrations of the testing plant in South Brooklyn, N. Y. The testing weir is fully equipped with facilities for accurately measuring the flow of water. 1700 w. Eng News—June 16, 1904. No. 63-407.

New Bedford, Mass.

The Quittacas Pumping Station and Other Features of the New Bedford Water Works. Reviews the history of the water-works system, describing and illustrating the new works. 5000 w. Eng Rec June 25, 1904. No. 63558.

New York.

Air-Lift Pumping Machinery at the Inverted Siphon of the New Croton Aqueduct, New York City. Begins an illustrated detailed description of the pumping apparatus. 3300 w. Eng Rec—May 28, 1904. Serial. 1st part. No. 63046.

The Installation of a Pneumatic Pumping Plant Arthur H. Diamont, Jr. Illustrating and describing the Harris pneumatic pumping plant for emptying the Harlem river siphon of the Croton Aqueduct, New York. 5800 w. Pro Am Soc of Civ Engrs—May, 1904. No. 62996 E.

Pumping Station.

A Small Concrete-Steel Sewage Pumping Station, at Newton, Mass. Illustrated description of an interesting plant for a suburb of Boston. 1500 w. Eng Rec—June 11, 1904. No. 63192.

Reservoirs.

Lake Cheeseman Dam and Reservoir. Discussion of the paper by Charles L. Harrison and Silas H. Woodard. 7200 w. Pro Am Soc of Civ Engrs—May, 1904. No. 62999 E.

Round Hill Dam, Spring Brook, Pennsylvania. Marshall O. Leighton. Describes the construction work, all of which was performed by the water supply company's own laborers working by the day. Ills. 1200 w. Eng Rec—June 11, 1904. No. 63188.

St. Louis.

The Water Supply System of St. Louis. W. E. Rolfe. An illustrated article giving the history, general outline and description of interesting features, with facts related. 5000 w. Eng Rec—June 4, 1904. No. 63097.

Settling.

The Automatic Removal of Solids from Water. Walter J. May. On the use of subsidence classifiers. 1000 w. Prac Eng —May 27, 1904. No. 63041 A.

Underground Water.

The Flowage of Underground Water.

John Wellington Finch. Extracts from a paper read before the Colorado Sci. Soc. Considers the ideal direction of movement, passage through the rocks, barriers to flow, the zonal disposition, &c. 4700 w. Ores & Met—June 15, 1904. Serial. 1st part. No. 63444.

Water Treatment.

The Treatment of Moorland Water to Prevent Action Upon Lead Pipes. C. Clemesha Smith and E. M. Chaplin. Abtract of a paper before the British Water Works Ass'n. A description of methods tried and the conclusions and cost. Ills. 4500 w. Eng News—June 23, 1904. No. 63487.

WATERWAYS AND HARBORS.

Belgium.

Navigable Waterways of Belgium. Information from the report of Mr. Hertslet, the British Consul General at Antwerp. 1500 w. Engr, Lond—May 27, 1904. No. 63133 A.

Dock Plant.

Middlesbrough Dock Electric and Hydraulic Power Plant. Vincent L. Raven. Gives the particulars of the installation and of the tests made at this dock on the North Eastern Railway, comparing hydraulic with electric. Ills. 5000 w. Inst of Mech Engrs—June, 1904. No. 63331 D.

Electric Traction.

Electric Equipment for Cornwall Canal. F. H. Leonard, Jr. Briefly outlines the hydraulic and generating equipment, and describes the lighting, lockages and weirs. 6 plates. 5000 w. Can Soc of Civ Engrs, Adv Proof—March 24, 1904. No. 63326 D.

Electrical Equipment for Cornwall Canal. F. H. Leonard, Jr. Read before the Can. Soc. of Civ. Engrs. Illustrates and describes the arrangements for power and lighting. 4500 w. Elec Rev, N. Y.—June 11, 1904. No. 63183.

The Use of Electricity on the Lachine Canal. L. A. Herdt. Brief description of this canal, showing its importance, and of the application of electricity for lighting the canal, locks, and bridges, for heating the power house and lock cabins, to open and close the lock gates, sluice valves and waste weirs, and to operate the swing bridges. Ills. 2500 w. Can Soc of Civ Engrs, Adv Proof—March 24, 1904. No. 63325 D.

Panama.

Health Conditions on the Isthmus of Panama. Dr. W. C. Gorgas. A statement of the sanitary conditions explaining the dangers to health and discussing the probability of keeping them under control 2200 w. Eng Rec—June 4, 1904. No. 63098.

MISCELLANY.

Drainage.

Tile Drainage. F. L. Knight. On Locating systems of tiling and matters related. 5000 w. Brick—June, 1904. No. 63480.

Land Changes.

Emergence and Submergence of Land. Abstract of an address by Sir Archibald Geikie, on the evidence supplied by the British Isles as to the problem of the causes of changes in the relative levels of sea and land. 6800 w. Nature—June 2, 1904. No. 63194 A.

Land Slide.

A Phenomenal Land Slide Discussion of paper by D. D. Clarke on the slide affecting the reservoirs of Portland, Oregon. 5500 w. Pro Am Soc of Civ Engrs —May, 1904. No. 62998 E.

ELECTRICAL ENGINEERING

COMMUNICATION.

Alarms.

Selective Alarm Calls (Die Stufenwecker). J. Baumann. A description of an electric alarm call system for telephone lines by which any one subscriber on a party wire may be called without disturbing the others. 2500 w. Zeitschr f Electrotechnik—May 15, 1904. No. 63-263 D.

Cables.

Multiple Telephone Cables with Air Insulation (Die Fabrikation Mehradriger Telephonkabel mit Luftisolation). J. Schmidt. Giving details of construction and methods of manufacture of several German makers. 3000 w. Zeitschr f Elektrotechnik—May 29, 1904. No. 63-264 D.

Space Telegraphy.

A Ferraris Field Detector of Hertzian Waves. Prof. Riccardo Arnò. Describes work performed in the electrical laboratory of the R. Instituto Tecnico Superiore of Milan. 1700 w. Elect'n, Lond—June 3, 1904. No. 63366 A.

Telegraphy.

The Telegraph Operator in the Railroad Service. John B. Taltevall. Read at meeting of Assn. of Ry. Tel. Supts. On instruction needed by operators to increase their efficiency. 1600 w. Ry Age—June 24, 1904. No. 63573.

Telephony.

Some Telephone Problems in Farming Communities. Howard S. Knowlton. Considers some of the difficulties to be met in farming districts, giving the record of a Colorado Telephone Co. as an example. 3500 w. Elec Wld and Engr—June 11, 1904. No. 63198.

The Use of Modern Telephones as Applied to Railroads. B. A. Kiser. Read before the Assn. of Ry. Tel. Supts. Shows the work actually being done on one of the railroads by the use of the telephone. 1500 w. Ry Age—June 24, 1904. No. 63574.

DISTRIBUTION.

Cables.

Protection of Cables from Arcs Due to the Failure of Adjacent Cables. W. G. Carlton. Briefly considers the methods of protection used for high-pressure cables, particularly in manholes. 1300 w. Trans Am Inst of Elec Engrs—June 21, 1904. No. 63351 D.

Capacity.

The Electrostatic Capacity of Wires. George D. Shepardson. Considers the things upon which the capacity of a wire depends, stating important cases. 2000 w. Reprint from Year Book of the Soc of Engrs., Univ. of Minnesota—Vol. XII, 1904. No. 63328 D.

Fuses.

A New Safety Fuse for High Pressure Currents (Eine Neue Schmelzsicherung für Hochspannungsstromkreise). F. Collischonn. The wire fuse is enclosed in a glass tube filled with oil. 3000 w. Elektrotech Zeitschr—June 9, 1904. No. 63-210 B.

Losses.

Lost and Unaccounted-for Current. C. W. Humphrey. Read before the Nat. Elec. Lgt. Assn. An explanation of the calculations of losses, known and unknown, for alternating and direct-current circuits, giving records of some of the results obtained. 3000 w. Elec Rev, N. Y.—June 4, 1904. No. 63096.

Networks.

An Analytical and Graphical Method of Computing Closed Networks (Eine Analytische und Graphische Methode zur Berechnung von Geschlossenen Leitungsnetzen). P. M. Verhoeckx. Applying the method of determinants to the transformation of the original equations; with practical examples. Two articles. 6000 w. Zeitschr f Elektrotechnik—May 15, 22, 1904. No. 63262 each D.

Regulation.

The Distribution of Electric Power from Transmission Systems. Dr. Louis Bell. Considers regulation the crucial point in the operation of power transmission plants for general distribution, discussing the details. 4500 w. Cassier's Mag—June, 1904. No. 63528 B.

Resistance.

The Determination of Resistances in the Conductors of Multiple-Wire Systems (Bestimenung des Isolationswiderstandes der Einzelleiter von Gleichstrom-Mehrleiter-anlagen während des Betriebes). Dr. J. Sahulka Discussing the distribution of resistances for continuous currents in multiple circuits. 3000 w. Elektrotech Zeitschr—May 26, 1904. No. 63203 B.

Rotary Concerters.

Efficiency Curves of Rotary Converters. A. S. McAllister. Come facts concerning the curves of rotary converters. 700 w. Elec Wld & Engr—June 4, 1904. No. 63109.

Sub-Station.

The Electric Installation of the Batignolles Freight Station of the Western Railway of France (Installations Electriques de la Compagnie de l'Ouest à la Gare de Batignolles-Marchandises). M. Soubrier. Describing a transformer substation, with details of switchboards and distribution. Serial. 1st part. 3000 w. Revue Tech—May 25, 1904. No. 63233 D.

Wiring.

The Continuous Protection of Conductors. Briefly reviews the wiring systems in general use, considering their advantages, and describes screwed stud fittings. Ills. 1100 w. Elec Rev, Lond—June 10, 1904. No. 63431 A.

ELECTRO-CHEMISTRY.

Batteries.

Experiments with a New Primary Cell. E. George P. Bousfield. Describes experiments carried out by the writer with a cell invented by W. R. Bousfield. Short discussion. 1200 w. Elec-Chem & Met—May, 1904. No. 63336 C.

New Batteries for the Electro-chemical Laboratory (Neue Batterien für das Elektrochemische Laboratorium). E. Weichmann. Illustrating and describing a variety of primary batteries suitable for laboratory research. 2000 w. Elektrochemische Zeitschr—June, 1904. No. 63281 D.

Cadmium Cell.

Report of the Committee on the Cadmium Cell. Preliminary report of the committee appointed to report on the preparation of materials and the construction of the cadmium or Weston cell. 2500 w. Trans Am Inst of Elec Engrs—May 17, 1904. No. 63350 D.

Convention.

The Bonn Meeting of the German Society of Electro-Chemists. Gives abstracts of the most interesting papers. 2500 w. Engr, Lond—June 10, 1904. No. 63440 A.

Smelting.

Electric Smelting in Europe. From the *Canadian Manufacturer.* Principal facts in the report of the commission sent to Europe to investigate electric smelting processes. Describes experiments with the Keller furnace. 1500 w. Ir Age—June 16, 1904. No. 63378.

The Electric Furnace for Iron and Steel. P. McK. Bennie. Abstract of a paper read before the Found. Assn. at Philadelphia. Alludes to the limitations of the electric furnace, considering the progress made in Europe in its application to iron and steel production, the classes of electric reduction, and of electric furnaces describing the Keller process. 3500 w. Ir Trd Rev—June 16, 1904. No. 63400.

The Electrothermic Production of Iron and Steel. Alfred Stansfield. Discusses the commercial possibility of producing iron and steel in the electric furnace, reviewing the attempts that have been made, the cost, &c. 4000 w. Can Soc of Civ Engrs, Adv Proof—March 1904. No. 63-327 D.

Storage Batteries.

Storage Battery Plate Construction. S. H. Rabenalt. Discussing the precautions to be observed to obtain the best results from batteries of the Planté type. 2500 w. Elec Wld & Engr—June 18, 1904. No. 63465.

ELETRO-PHYSICS.

Induction Coils.

Induction Coil Design. Mortimer A. Codd. Discusses points in design which affect the efficiency. 1500 w. Elec Rev, Lond—May 20, 1904. Serial. 1st part. No. 63009 A.

Radio Activity.

The Properties and Changes in the Emanation from Radium (Emanation du Radium, ses Propriétes et ses Changements). Sir William Ramsay. An authoritative account of the experiment, showing the change of radium emanation into helium. 3500 w. Comptes Rendus—June 6, 1904. No. 63258 D.

The Radio-activity of Gases Disengaged from Waters of Mineral Springs (Sur la Radio-activité des Gaz qui se Dégagent de l'Eau des Sources Thermales). P. Curie and A. Laborde. Giving results of tests from a number of springs, showing a perceptible and variable amount of radio activity. 1500 w. Comptes Rendus—May 9, 1904. No. 63250 D.

Spark Potentials.

Conditions which Influence Spark Potential Values. E. A. Ekern. Gives facts proving that the spark potential for a given gap and pressure is a variable quantity, depending on the shape of the electrodes and the proximity of solid dielectrics to the electrodes. Ills. 1600 w. Sib Jour of Engng—June, 1904. No. 63-392 C.

Thermo-Electricity.

Thermo-Electric Researches (Ueber Thermoelektrische Versuche). Dr. C. Déguisne. A study of the production of electric currents in a single wire by a moving source of heat. 1200 w. Elektrotech Zeitschr—May 26, 1904. No. 63204 B.

Waves.

Alternating-Current Wave Form Analysis. S. M. Kintner. Gives details of one of the methods of harmonic analysis, discussing the theory and giving such instructions as are needed to carry out the analysis. 2500 w. Elec Wld & Engr—May 28, 1904. No. 63033.

On a New Standard of Wave-length. Dr. James E. Ives. Illustrates and describes the apparatus used, and the method. Also editorial. 3000 w. Elec Wld & Engr—June 4, 1904. No. 63108.

Wave Form Variations of a Long-Distance Line. George H. Rowe. Gives a map showing the lines of the Standard Electric Co.'s system, in which the oscillographic curves were taken, describes the instrument and method of testing, and gives a summary of conclusions for consideration. 2200 w. Trans Am Inst of Elect Engrs—May 17, 1904. No. 63346 D.

GENERATING STATIONS.

Alternators.

The Pressure Drop in Alternating Generators (Ueber den Spannungsabfall in Wechselstromgeneratoren). Dr. H. Behn-Eschenburg. Discussing the mathematical method of computing the drop in voltage for a proposed machine. 4000 w. Elektrotech Zeitschr—May 19, 1904. No. 63-200 B.

British Stations.

Some British Central Electric Power Stations. H. F. Parshall. Brief illustrated descriptions of the more important stations designed by the writer, representing modern practice in Great Britain. 3000 w. Cassier's Mag—June, 1904. No. 63533 B.

Brushes.

Why Use Carbon Brushes on the Modern Dynamos? J. W. Burleigh. Discusses the substitution of metal for carbon brushes, giving some designs. Ills. 700 w. Elec Rev, Lond—June 10, 1904. No. 63432 A.

Cape Town.

Cape Town Corporation Electricity

Works. Information concerning the new electricity works recently opened. Ills. 3200 w. Electn, Lond—May 27, 1904. Serial. 1st part. No. 63118 A.

Dynamos.

Compensating and Compound Windings for Continuous--Current Dynamos (Kompensierende und Compoundierende Wendepolwickelungen für Gleichstrommaschinen). J. Seidener. Discussing the methods of reducing sparking by compensating winding. 1800 w. Zeitschr f Elektrotechnik—June 12, 1904. No. 63-268 D.

High Potentials.

The Advisability and Methods of Grounding the Neutral on High Potential Alternating-Current Generators. George N. Eastman. Read before the Nat. Elec. Lgt. Assn. Presents conditions resulting in a production of dangerous potentials relative to earth, showing these conditions will only arise in a system which is insulated from the earth. 2800 w. Elec Rev, N. Y.—June 11, 1904. No. 63181.

Humming.

The Humming of Dynamos (Ueber das Pfeifen von Maschinen). J. Fischer-Hinnen. A discussion of the causes of the humming noise emitted by dynamos, and its alleviation. 1500 w. Zeitschr f Elektrotechnik—June 5, 1904. No. 63266 D.

Hydro-Electric.

Electric Power from Shawinigan Falls, Canada. Wallace C. Johnson. Gives an illustrated description of the hydraulic development. 4000 w. Cassier's Mag—June, 1904. No. 63529 B.

Electric Power from Shawinigan Falls, Canada. Ralph D. Mershon. An illustrated detailed description of the electric transmission plant. 3500 w. Cassier's Mag—June, 1904. No. 63530 B.

The Garvin's Falls Dam and Canal. Illustrated detailed description of the plant under construction for the Manchester Traction, Light and Power Co., in New Hampshire. 3000 w. Eng Rec—May 28, 1904. No. 63044.

The Hydro-Electric Station at Kykkelsrud, Norway (Usine Hydro-Electrique de Kykkelsrud). With plan of buildings and details of turbines for the development of 12,000 horse-power. There are 44,000 h. p. available. 1800 w. 1 plate. Génié Civil—May 21, 1904. No. 63227 D.

The Largest Electric Water Power Station in New Hampshire. An illustrated article giving facts of interest relating to the development at Garvin's Falls, which furnishes light and power for Manchester. 3800 w. Elec Wld & Engr—May 28, 1904. Serial. 1st part. No. 63030.

Isolated Plant.

Power Plant of the Whitlock Branch of the American Cigar Company, Richmond, Va. Illustrated description of a plant driven by means of alternating-current motors, chiefly interesting from the standpoint of its design. 1700 w. Eng Rec—June 11, 1904. No. 63190.

Parallel Driving.

The Requirements Upon Motors for the Parallel-Driving of Alternators (Anforderungen an Antriebmotoren beim Parallel betrieb von Wechselstrom-dynamos). E. Rosenberg. Discussing especially matters of speed-regulation. Two articles. 8000 w. Zeitschr d Ver Deutscher Ing—May 28, June 4, 1904. No. 63-215 each D.

Paris.

A Large, Modern Paris Generating Plant. C. L. Durand. Illustrated description of a large plant recently erected by the Compagnie Parisienne de l'Air Comprimé. 3000 w. Elec Rev, N. Y.—May 28, 1904. No. 63025.

Sparking.

Predetermination of Sparking in Direct-Current Machines. W. L. Waters. Considers the most important conditions which effect the sparking, deducing a formula that will give fairly accurate results when applied to machines similarly designed, and some idea when applied to different designs. 3000 w. Trans Am Inst of Elec Engrs—May 17, 1904. No. 63344 D.

Switzerland.

The New Electric Works at Neuchatel, Switzerland. A. Steere. Illustrated description of an interesting installation. 1600 w. Eng Rec—June 4, 1904. No. 63099.

Utah.

Bear River Power Plant and Utah Transmission Systems. Illustrates and describes a plant which utilizes the surplus water of an irrigation system during the season of high water. 1500 w. Elec Wld & Engr—June 18, 1904. Serial. 1st part. No. 63462.

LIGHTING.

Arcs.

Alternating Current Arc Systems. Richard Fleming. Illustrates and describes appliances used and the lamps of various types. 2000 w. Engr, U S A—June 1, 1904. No 62092 C.

Arc Light Photometry. C. P. Matthews. Describes two different equipments for simple or semidirectional arc-light photometry. Ills. 2500 w. Engr, U S A—June 1, 1904. No. 63094 C.

Series Alternating Current Arc Lighting Plant in the Union Stock Yards. Illustrates and describes the largest series enclosed arc lighting system installed in Chicago. 2200 w. Engr, U S A—June 1, 1904. No. 63091 C.

Car Lighting.

Power Required for the Electric Lighting of Passenger Carriages on the Stone System. Mr. Staby in *Zeitung des Vereins.* Information on the amount of energy consumed. 1200 w. Bul Int Ry Cong—May, 1904. No. 63124 E.

The Boehm System of Electric Lighting for Trains. The system obtains its current from a generator driven by one of the axles of the train. Its chief interest lies in the method employed to regulate the speed and voltage of the generator. Ills. 900 w. Elec Rev, Lond—June 17, 1904. No. 63541 A.

Illumination.

Electricity and Light, Charles Proteus Steinmetz. Discusses the advance being made in electric lighting, explaining the action of the incandescent lamp, the gases and vapors that are made luminous, the mercury arc, and the magnetite arc lamp. 2800 w. Cassier's Mag—June, 1904. No. 63531 B.

Mills.

The Electric Lighting of Weaving Sheds and Spinning Mills. Discusses the subject in regard to England, giving facts in the inspector's report. 1400 w. Prac Engr—May 27, 1904. Serial. 1st part. No. 63-040 A.

New England.

Rise of Electric Lighting in New England. Alton D. Adams. A concise review of the early history. 1500 w. Elec Wld & Engr—May 28, 1904. No. 63031.

Photometry.

Candle-Power Tests of Cooper Hewitt Mercury Vapor Lamp. L. A. Freudenberger. Describes tests made at Delaware College, Newark, Del., on a vapor lamp known commercially as Type H-4. 600 w. Elec Wld & Engr—June 25, 1904. No. 63552.

Principles of Photometry. An explanation of the principles for measuring the intensity of light. Ills. 2200 w. Engr, U S A—June 1, 1904. No. 63093 C.

Rating.

The Proper Commercial Rating of Incandescent Lamps. E. Leavenworth Elliott. Points out what the writer considers the shortcomings of the present accepted method of rating, explaining the scientific principles involved. 1500 w. Cent Sta—June, 1904. No. 63304.

Three-Wire.

A Three-Wire Five-Hundred-Volt Lighting System. Walter I. Barnes. Read before the Nat. Elec. Lgt. Assn. Describes the construction work, giving an outline of the development of the Narragansett Elec. Lgt. Co. 3200 w. Elec Rev, N Y—May 28, 1904. No. 63-027.

MEASUREMENT.

Diagrams.

Diagrams and Measurements for Polyphase Motors (Diagramm und Ausmessung von Drehstrommotoren). Hugo Grob. An extended study of the application of the Heyland circle diagram. Two articles. 15,000 w. Elektrotech Zeitschr—June 2, 9, 1904. No. 63207 each B.

Electrical Survey.

Method of Making Electrical Survey of Rochester, N. Y. An account of a special survey and report made by Albert R. Herrick, describing methods. Ills. 3000 w. Munic Engng—June, 1904. No. 63324 C.

Space Telegraphy.

The Telefunken Ondometer for the Measurement of Wireless Telegraphy. Illustrates and describes an apparatus for measuring wave-lengths. 900 w. Sci Am Sup—June 25, 1904. No. 63537.

Symbols.

Graphical Symbols for Elements in the Technology of Weak Currents—Einheitliche Graphische Bezeichnungen in der Schwachstromtechnik). J. Baumann. Advocating the use of certain symbols for batteries, transformers, interrupters, etc. 2500 w. Elektrotech Zeitschr—June 2, 1904. No. 63206 B.

Testing.

Data and Tests on a 10,000-Cycle-per-second Alternator. B. G. Lamme. Presents data of the machine and the tests obtained. Ills. 2200 w. Trans Am Inst of Elec Engrs—May 17, 1904. No. 63-347 D.

Practical Alternating Current Testing. Charles F. Smith. Begins a study of the application of general experimental laws to the case of alternating-current machinery. 3000 w. Mech Engr—June 18, 1904. Serial. 1st part. No. 63546 A.

Test of a Direct-Current Dynamo by the Schüttorf Machine Works. (Prüfung einer Gleichstrom Dynamomaschineder Schüttorfer Maschinenfabrik). W. Winkelmann. With detailed illustrations of the machine and data and results of test. 1500 w. Elektrotech Zeitschr—May 19, 1904. No. 63201 B.

Units.

Electrotechnical Measuring Systems (Ueber Elektrotechnische Mass-systeme). Fritz Emde. Outlining a general system of physical measurements and units for discussion at the St. Louis Electrical Congress. 10,000 w. Elektrotech Zeitschr—May 26, 1904. No. 63205 B.

Wattmeters.

An Expression for the Torque of a Polyphase Wattmeter. F. R. Stowe. Mathematical discussion. 500 w. Elec Wld & Engr—May 28, 1904. No. 63032.

MOTORS.

Induction Motors.

A Hopkinson Test for Multiphase Induction Motors. R. W. Weekes. Describes tests carried out, the method of testing, &c, giving results. 3000 w. Elec Engr, Lond—June 17 1904. No. 63543 A.

Induction Motor Design as Determined by Commercial Requirements. J. B. Wiard. Outlining the fundamental principles which govern the design, indicating the different forms which are on the market commercially. 5000 w. Jour Worcester Poly Inst—May, 1904. No. 63,-317 C.

Single-Phase Commutator Motors (Ueber Einphasenkommutatormotoren). Karl Pichelmayer. A review of the various forms of single-phase motors, comparing them with the continuous-current motor. 7000 w. Elektrotech Zeitschr—June 2, 1904. No. 63209 B.

Single-Phase Motors. George T. Hanchett. A non-mathematical description of the rotative principle of the single-phase induction motor. 1500 w. Cent Sta—June, 1904. No. 63303.

The Reluctance of the Air-Gap in the Induction Motor. N. Pensabene. A study of the case of open slots in the stator and totally enclosed slots in the rotor. 900 w. Elec Engr, Lond—June 17, 1904. No. 63544 A.

The Single-Phase Induction Motor. William S. Franklin. A mathematical discussion of the design. 2700 w. Trans Am Inst of Elec Engrs—May 17, 1904. No. 63348 D.

Repulsion Motor.

The Principles of the Repulsion Motor. George T. Hanchett. A discussion of its principles of operation. Diagrams. 2000 w. St Ry Jour—May 28, 1904. No. 63029 C.

The Repulsion Motor. F. W. Carter. Discusses the principles and properties of a single-phase alternating-current motor whose speed characteristic droops considerably with increase of train resistance. 1000 w. Elec Rev, Lond—May 27, 1904. Serial. 1st part. No. 63116 A.

Self Induction.

Effect of Self-Induction on Railway Motor Commutation. E. H. Anderson. Deals with fundamental features of railway motor commutation, illustrating by oscillograph records. 2700 w. Trans Am Inst of Elec Engrs—May 17, 1904. No. 63345 D.

Synchronous Motors.

Influence of the Line on the Parallel Operation of Synchronous Motors. Abstracts of the papers by Signor Rebora and Signor Guido Jemenza, in the *Transactions* of the Italian Assn. of Elec. Engrs. Also Editorial. 4000 w. Elec Wld & Engr—June 18, 1904. No. 63463.

Synchronous Motors for Regulation of Power-Factor and Line Pressure. B. G. Lamme. Shows how a synchronous motor can be used to establish leading or lagging currents in its supply system, and as a regulator. 4500 w. Trans Am Inst of Elec Engrs—June 21, 1904. No. 63352 D.

Variation.

Variation of Motor Speed with Variable Line Voltage. J. L. Dickson. Outlines, in as simple a manner as possible, two different methods of investigating this question. 600 w. Elec Wld & Engr—June 18, 1904. No. 63464.

TRANSMISSION.

Line.

A One-Hundred Mile Transmission Line. Robert Howes. Read before the Nat Elec Lgt Assn. Briefly describes the essential features of the plant, the results obtained and difficulties encountered. 3800 w. Elec Rev, N Y—May 28, 1904. No. 63026.

Line Protection.

The Protection of High-Pressure Transmission Lines from Static Discharges. H. C. Wirt. Comments on devices now in use. 1200 w. Trans Am Inst of Elec Engrs—June 21, 1904. No. 63356 D.

Long-Distance.

Limitations of Long-Distance Electric Power Transmission. Paul M. Lincoln. Considers the commercial limits and the engineering limits. 5000 w. Cassier's Mag—June, 1904. No. 63525 B.

Long-Distance Power Transmission. Charles F. Scott. Considers its economic, and particularly its engineering aspects. 4500 w. Cassier's Mag—June, 1904. No. 63524 B.

The Development of Electric Power Transmission. Lewis Buckley Stillwell. Illustrating and describing cables, insulators, and general details of long-distance high-tension transmission. 8000 w. Cassier's Mag—June, 1904. No. 63523 B.

Long Spans.

Long Spans for Transmission Lines. F. O. Blackwell. Considers the principal causes of interruption in long-distance transmission, and the remedies to be gained by substituting steel tower construction with long spans for a wooden pole line. 2800 w. Trans Am Inst of Elec Engrs—June 21, 1904. No. 63353 D.

Parallel Operation.

Conditions for Continuous Service Over Lines Operated in Parallel. M. H. Gerry, Jr. Advocates the use of multiple lines and proper appliances. 800 w. Trans Am Inst of Elec Engrs—June 21, 1904. No. 63354 D.

Spier Falls.

Hudson River Power in the General Electric Works. Describes the power transmission from Spier Falls, 30 miles distant. Ills. 2800 w. Elec Wld & Engr —June 11, 1904. No. 63197.

Transformers.

Discussion on "The Relative Fire-Risk of Oil and Air-Blast Transformers. 28,500 w. Trans Am Inst of Elec Engrs—March 25, 1904. No. 63349 D.

The Berthier Actino-Electric Transformer. Emile Guarini. An illustrated article sketching the main features of two forms of apparatus for producing electricity from light. 1500 w. Sci Am—June 18, 1904. No. 63383.

The Use of Ground Shields in Transformers. J. S. Peck. Considers the grounding of the low-pressure winding at the neutral point is a safer, more practical and cheaper method of protection. 600 w. Trans Am Inst of Elec Engrs—June 21, 1904. No. 63355 D.

Transformers for Long-Distance Transmission. J. S. Peck. An illustrated description of the modern transformer. 4000 w. Cassier's Mag—June, 1904. No. 63526 B.

MISCELLANY.

Cost.

The Cost of Electric Energy. G. L. Addenbrooke. A study of the prices at which electric supply can be furnished in England, especially considering supply from a central source. 4800 w. Engng—June 3, 1904. No. 63368 A.

Heating.

Electric Heating and Cooking (Ueber das Elektrische Heizen und Kochen). W. Krejza. With illustrations of a variety of electric stoves and heaters. Two articles. 4000 w. Zeitschr f Elektrotechnik—June 5, 12, 1904. No. 63267 each D.

Submarine Mines.

Electrically Operated Submarine Mines. Waldon Fawcett. Brief explanation of the operation of electrical mines, with remarks and illustrations. 1600 w. Elec Rev, N Y—June 11, 1904. No. 63182.

Welding.

Electric Welding Development. Elihu Thomson. Reviews applications made of the electric weld, showing its importance in the industries. Ills. 2000 w. Cassier's Mag—June, 1904. No. 63532 B.

GAS WORKS ENGINEERING

Acetylene.

Purification and Combustion of Acetylene. From *La Nature.* Explains the process proposed by Prof. Ullmann, in which "heratol" is used to purify the acetylene, and describes the burners most successful. Ills. 1200 w. Sci Am Sup—June 18, 1904. No. 63387.

Automatic Lighting.

Westenholz's Patent Automatic Gas Lighter and Extinguisher. An account of a new invention from Denmark, stating its merits and advantages. Ills. 1400 w. Jour Gas Lgt—June 7, 1904. No. 63376 A.

Benzine.

The Decomposition of Benzine at High Temperatures. G. W. McKee. Read before the Canadian Sec. of the Soc. of Chem. Ind. An account of experiments made to obtain light on the effect of transition temperatures. 1000 w. Gas Wld—May 21, 1904. No. 63001 A.

Charging.

Charging Machinery at Lyons. M. Boutan. Read before the Soc. Tech. de L' Ind. du Gaz en France. Illustrated description of the charging machinery and its working. 2500 w. Gas Wld—June 18, 1904. No. 63504 A.

Oerlikon and Bertrand Chargers and Dischargers. M. J. Thelliez. Read before the Soc. Tech. de L' Ind. du Gaz en France. An illustrated article explaining the charging and discharging movement, the lifting and lowering to different levels, &c. 900 w. Gas Wld—June 18, 1904. No. 63505 A.

Combustion.

The Mechanism of Combustion. Harold B. Dixon. Lecture before the Inst. of Gas Engrs. Reviews the theories advanced and discusses the subject in detail. Ills. 11,000 w. Gas Wld—June 11, 1904. No. 63491 A.

Comparison.

Coal Gas and Water Gas. Alton D. Adams. Discusses the relative advantages of each and the cost of manufacture as shown in plants of various capacities in Massachusetts. 1700 w. Mines and Min —June, 1904. No. 63144 C.

Condensation.

Condensation of Illuminating Gas. Dr. Harold G. Colman. Read before the Inst. of Gas Engrs. Considers chiefly what may be called the action of the condensing apparatus as a washer or scrubber for the various vapors present in the hot gases issuing from the retorts. General discussion. 9500 w. Gas Wld—June 11, 1904. No. 63492 A.

Enrichment.

Water Gas Tar Used in Generators for Enrichment. Henry I. Lea. Read before the Ohio Gas Lgt. Assn. Reports plants that have used oil tar in generators and the results, discussing its value. General discussion. 3800 w. Am Gas Lgt Jour—May 30, 1904. No. 63034.

Gas Coals.

The Analytical Valuation of Gas Coals. G. P. Lishman. Abstract of a paper submitted to the Inst. of Min. Engrs. Report of an investigation to determine the value. 2500 w. Gas Wld—June 4, 1904. No. 63-364 A.

Gasholders.

Experience at Middlesbrough with Gasholder Tanks on Marshland. David Terrace. Read before the Inst. of Gas Engrs. On the difficulties and means adopted to remedy them. Ills. 2200 w. Gas Wld—June 11, 1904. No. 63490 A.

Gas Stoves.

The Gas Stove Considered from a Chemical and Sanitary Standpoint. Francis C. Phillips. Describes types at present used, and tests made where natural gas was used; discussing the effect upon health from the products of combustion. 4000 w. Pro Engrs' Soc of W Penn—Feb., 1904. No. 63388 D.

High Pressure.

Distributing Gas at 25 lbs. Pressure per Square Inch. George Helps. Reviews what has been done in America and in England with high-pressure gas, discussing the advantages and disadvantages, and describing the Nuneaton installation. 4500 w. Gas Wld—May 28, 1904. No. 63-114 A.

The Flow of Gas in Mains, and Distribution at High Pressure. Read before the Inst. of Gas Engrs. by W. C. Unwin. A discussion of this subject, the difficulties, and American practice in high-pressure distribution. General discussion. Diagrams. 11000 w. Gas Wld—June 11, 1904. No. 63494 A.

Illumination.

Artificial Gas Illumination in Relation to Natural Light. William Sugg. Read before the Inst. of Gas Engrs. A study of natural light and the effect of artificial light of high power on the eye sight, with suggestions. Ills. 3200 w. Gas Wld—June 11, 1904. No. 63496 A.

Meters.

Ten Years' Experience with the Prepayment Meter. Alfred Colson. Read before the Inst. Gas Engrs. Discusses the working of the slot meter system in Leicester, Eng., giving the results obtained, the methods of collecting and inspecting, &c. Also discussion. 9000 w. Gas Wld—June 11, 1904. No. 63489 A.

New Works.

The New Works of the Hastings and St. Leonard's Gas Company. An illustrated account of the progress at Glyne Gap. 4800 w. Jour Gas Lgt—May 31, 1904. No. 63358 A.

Operation.

The Granton Gas Works of the Edinburgh and Leith Gas Commissioners. Analysis of the manufacturing costs and charges for the year ending May 15. 1904. 1600 w. Jour Gas Lgt—May 31, 1904. No. 63357 A.

Photometry.

The Photometrical Valuation of Gas. H. Leicester Greville. Remarks on how photometry as a science can best be combined with gas testing. 1700 w. Jour Gas Lgt—May 24, 1904. No. 63039 A.

Small Coal.

The Uses of Small Coal. Remarks on the influence of washeries on the coal industry, with reference to a paper by Mr. Mackey, read before the Soc. of Chem. Ind. 1900 w. Jour Gas Lgt—May 24, 1904. No. 63038 A.

Stoking Machinery.

De Brouwer Stoking Machinery at Derby. J. Ferguson Bell. Read before the Inst. of Gas Engrs. An illustrated description of the plant, with results obtained by continuous working during the past eight months. General discussion. 11800 w. Gas Wld—June 11, 1904. No. 63493 A.

INDUSTRIAL ECONOMY

Apprentices.

Apprentices in the Foundry. O. P. Briggs. Read before the New England Found. Assn. Discusses the character and qualifications of the boy, the attitude of the foreman, methods of raising the standard, &c. 4000 w. Ir Trd Rev—June 23, 1904. No. 63501.

Combinations.

Rings, Combinations and Trusts (Ringe, Kartelle und Trusts). Georg Gothein. An examination of industrial combinations from the continental viewpoint. 6000 w. Zeitschr d Ver Deutscher Ing—May 28, 1904. No. 63216 D.

Competition.

Mining Royalties and the Iron Trades. Some Conditions of Foreign Competition. T. Good. Discusses conditions in England detrimental to the iron industry. 2800 w. Engng Rev—June, 1904. No. 63538 B.

Education.

The Electrotechnical Institute of the Technical High School at Vienna (Das Elektrotechnische Institut der k. k. Technischen Hochschule in Wien). Prof. Karl Hochenegg. An illustrated account of the electrical laboratory of the Vienna technical high school. 4500 w. Zeitschr d Oesterr Ing a Arch Ver—May 13, 1904. No. 63236 D.

The Technical High School at Darmstadt (Die Grossherzogliche Technische Hochschule in Darmstadt). O. Berndt. With plan of the buildings, view of the new electrical building, and an account of the growth of the school. 1200 w. Zeitschr d Ver Deutscher Ing—June 11, 1904. No. 63220 D.

The Tuition (?) of Electrical Engineering. James Pigg. Read before the Newcastle Soc. of the Inst. of Elec. Engrs. Considers some of the advantages of other methods than those in use, especially correspondence schools. 5300 w. Elec Engr, Lond—June 3, 1904. Serial. 1st part. No. 63367 A.

Efficiency.

The Conditions of Maximum Productive Efficiency. Ralph Neville. Discussing the necessity for incentive as a condition for efficient production in all departments of industry. 3500 w. Engineering Magazine, July, 1904. No. 63282 B.

Indexing.

Engineering Index and Library Work. G. W. Lee. Describes the system in use in the reference library of Stone & Webster, of Boston. Also Editorial. 2200 w. Eng News—June 16, 1904. No. 63410.

Inspection.

Inspection as a Factor in Cheap Production. Charles U. Carpenter. Discussing inspection as a necessary complement of standardized production, for the maintenance of accurate work. 3000 w. Engineering Magazine—July, 1904. No. 63-289 B.

Iron Warrants.

Pig Iron Warrant System and the Foundry. George H. Hull. Read before the Am. Found. Assn. Discusses this question in connection with the proposed letting of a contract for the large amount of castings in connection with the Pennsylvania R. R. Tunnels in New York. 3300 w. Ir Trd Rev—June 23, 1904. No. 63502.

Laboratory.

A Factory Research Laboratory. Illustrated description of the laboratory in the cycle works of Messrs. Rudge-Whitworth, Ltd., an exceptionally fine example. 2200 w. Engr, Lond—June 10, 1904. Serial. 1st part. No. 63438 A.

The New Power House and Mechanical Laboratory of the Technical High School at Darmstadt (Das Neue Kraftwerk und das Neue Maschinenbaulaboratorium der Technischen Hochschule Darmstadt). Prof. M. F. Gutermuth. Describing especially the steam generating plant, and boilers, superheaters, &c. Serial. Part I. 3000 W. Zeitschr d Ver Deutscher Ing—June 11, 1904. No. 63-221 D.

The Testing Laboratory of the Conservatorie des Arts et Metiers (Laboratoire d'Essais du Conservatoire des Arts et Metiers). A. Boyer-Guillon. Describing especially the department relating to the testing of automobiles, steam engines, and other machines. Two articles. 5000 w. 1 plate. Génie Civil—May 21, 28, 1904. No. 63225 each D.

Office Equipment.

Mechanical Aids in Factory Office Equipment. George Harvey Seward. With numerous illustrations of mechanical computers, slide rules, and other calculating machines adapted for office and factory use. 5000 w. Engineering Magazine—July, 1904. No. 63291 B.

Peru.

The Way into Peru. F. J. Schafer. Describes an important project for opening up one of the richest and most fertile districts of Peru, showing that improvement in transport facilities is the one thing needful, and discussing the difficulties. Ills. 2800 w. Page's Mag—June, 1904. No. 63515 B.

Premium System.

The Premium System Applied to Mining. H. Foster Bain. Considers some of the methods by which costs of mining may be reduced. 2200 w. Mines & Min—June, 1904. No. 63149 C.

Promotion.

Light Railway and Tramway Promotion Procedure. Arthur P. Poley. The first of a series of articles giving an account of the procedure and rules applicable to applications made by promoters in England. 3000 w. Tram & Ry Wld—June 9, 1904. No. 63484 B.

Railways.

Railway Economics. Editorial review of the statement of the Board of Trade on the results of the work of the railways of the United Kingdom during the past year. 1800 w. Engng—May 20, 1904. No. 63014 A.

Technology.

Law, Industry and Technology (Recht, Wirtschaft und Technik.) Dr. Herm. Beck. An address showing the relation of technology to the other elements of civilization. Two articles. 8000 w. Zeitschr—d Ver Deutscher Ing—May 14, 21, 1904. No. 63214 each D.

Wages.

Wage Systems and Their Bearing upon Output. George N. Barnes. An examination of the various forms of piece work, contract, premium, bonus and other wage systems, and their relation to the industrial position of the workman. 4000 w. Engineering Magazine—July, 1904. No. 63283 B.

Works Management.

A Bibliography of Works Management. Hugo Diemer. Listing the most important books which have been written on the subject in the English language, with brief descriptive notes, followed by a comprehensive index of the current literature of the subject from 1885 to date. 15000 w. Engineering Magazine—July, 1904. No. 63292 B.

MARINE AND NAVAL ENGINEERING

Approximate Integration.

New Rules for Approximate Integration. George R. McDermott. Gives a résumé of results of a study of existent rules for various spacings of ordinates, and explains a rule independently derived for the solution of a stated problem. 1500 w. Sib Jour of Engng—June, 1904. No. 63391 C.

Battleships.

The Tendency of Battleship Design. Discusses recent changes and the characteristics of a proposed battleship to meet present conditions. 1600 w. Engr, Lond—June 10, 1904. No. 63436 A.

The United States Battleship Virginia. Illustrations, plans and detailed descriptions of this recently launched vessel. 3000 w. Marine Engng—June, 1904. No. 62985 C.

Cable Steamer.

The Cable Steamer "Pacific." Illustrated detailed description of the latest built ship of this class. 3000 w. Electn, Lond—May 20, 1904. No. 63010 A.

Electrical Apparatus.

Electricity in the British Naval and Merchant Marine. Sydney F. Walker. Reports the progress, and describes some of the arrangements. 1600 w. Marine Engng—June, 1904. No. 62987 C.

Explosives.

The Detonation of Explosives under Water (Dètonation sous l'Eau des Substances Explosifs). M. Jacob. A study of the relation of the compressibility of the fluid to the action of the explosive. 1200 w. Comptes Rendus—May 24, 1904. No. 63253 D.

Freight Carriers.

Freight Carriers of the Great Lakes. Illustrated review of the types of vessels used on the Great Lakes at various times, especially cargo vessels, with some points in regard to their history. 3500 w. Marine Rev—June 2, 1904. No. 63087.

Recent Developments in Cargo and Intermediate Steamers. Edwin William De Rusett. An illustrated article considering the type, size, construction, capacity, cargo appliances, and economy of working, showing the great progress made during the five years. 5000 w. Marine Rev—June 2, 1904. No. 63086.

The Development of the Freight Carrier in the Atlantic Coastwise Trade. Ray Morris. An illustrated article discussing the development of coastwise freight traffic. 4000 w. Marine Rev—June 2, 1904. No. 63085.

Gunboat.

H. M. Gunboat Widgeon. Illustrated description of a twin-screw shallow-draught vessel, fitted with Yarrow's patent movable flap. 900 w. Engr, Lond—May 27, 1904. No. 63136 A.

Light Outfits.

Electric Lighting Outfit for Launches. D. A. Richardson. An illustrated article discussing the requirements. 1500 w. Marine Engng—June, 1904. No. 62986 C.

Rolling.

On the Heeling and Rolling of Ships of Small Initial Stability. A. Scribanti. Investigations of the influence which a varying amount of initial stability can exert on some mechanical features of a given ship. 2800 w. Engng—May 27, 1904. Serial. 1st part. No. 63130 A.

Salvage.

Marine Salvage and Wreck Raising. Describes the equipment of the salvage vessel Ranger, and some information of the work. 1500 w. Engr, Lond—May 27, 1904. No. 63135 A.

Steamboats.

Hudson River Steamboats. An illustrated article, especially describing the latest addition to this fleet—the C. W. Morse, a million-dollar craft for the People's Line. 4500 w. Naut Gaz—June 2, 1904. No. 63151.

Steamboat C. W. Morse, for the Hudson River. Illustrated description of a large side-wheel steamboat for the People's line between New York and Albany. 1800 w. Marine Engng—June, 1904. No. 62989 C.

Steam Navigation.

Progress of Steam Navigation. Robert Caird. Presented before the Royal Philosophical Soc., Glasgow. A review of the progress from 1802 to 1902. The present article considers mainly British merchant shipping of the largest size. 4500 w. Naut Gaz—June 16, 1904. Serial. 1st part. No. 63396.

Tug Boat.

Shallow-Draft, Twin-Screw Tug Boat for the Northwest. Illustrated description of a boat intended for use in towing logs on the Saskatchewan River. 400 w. Marine Engng—June, 1904. 62988 C.

MECHANICAL ENGINEERING

AUTOMOBILES.

Accumulators.

Notes on Recharging Accumulators. On the mistake of charging a 4-volt accumulator with 5 or 6 volts at the terminals. 900 w. Motor Car Jour—June 18, 1904. No. 63540 A.

Car Houses.

Motor car houses. B. Wyand. Suggestions for erecting buildings suitable for small and large vehicles. Ills. 900 w. Autocar—June 18, 1904. No. 63550 A.

Commercial Vehicles.

Recent English and French Merchandise and Passenger Wagons (Neuere Englische und Französische Motorwagen für Personen und Güter). A. Heller. Illustrating recent trucks, surries, fire-engines and commercial vehicles. Serial. Part I. 3000 w. Zeitschr d Ver Deutscher Ing—June 4, 1904. No. 63219 D.

The Automobile in Business. J. A. Kingman. Considers these vehicles as used in New York City; the cost and the expense of running, and the general operation. Ills. 3800 w. Rev of Revs—June, 1904. No. 63309 C.

Petrol Car.

The "Ford" Petrol Car. Illustrated detailed description of a light car built in Detroit. 1800 w. Auto Jour—June 11, 1904. Serial. 1st part. No. 63426 A.

The 1904 Clement Petrol Cars. Illustrated description of these cars, built in Paris. 1200 w. Auto Jour—May 28, 1904. Serial. 1st part. No. 63112 A.

Racer.

The Six-Cylinder Napier Racer. Brief Illustrated description. 800 w. Auto Jour—June 18, 1904. No. 63549 A.

Radiators.

Experiments Showing the Efficiency of Radiators for Gasoline Automobiles. Gives results of tests made under the supervision of William S. Conant and Benjamin Briscoe. 3500 w. Sci Am Sup—June 11, 1904. No. 63307.

Speed Gears.

The Balance Gear Explained. Hurbert C. Clarke. An illustrated description of the balance or differential gear. 2000 w. Autocar—June 4, 1904. No. 63361 A.

The Columbia Bicycle Two-Speed Gear. Illustrated description of a combined free-wheel, brake and speed-changing mechanism. 1700 w. Mach, N. Y.—June, 1904. No. 63065 C.

The 8 H.-P. De Dion Three-Speed Gear. Illustrated detailed description. 1300 w. Autocar—June 11, 1904. No. 63428 A.

Steam Car.

The Turner-Miesse Steam Car. Illustrated detailed description. 1200 w. Motor Car Jour—May 28, 1904. Serial. 1st part. No. 63095 A.

Sutton Engine.

The Sutton "Heavy" Oil Engine. An illustrated detailed description of the Sutton system and its use on motor cars. 3300 w. Auto Jour—June 4, 1904. No. 63360 A.

Tires.

Non-Skidding Tires and Protective Bands for Use on the Wheels of Automobiles. Illustrates and describes types tried in the tests in France, giving points determined by the tests. 800 w. Sci Am—June 25, 1904. No. 63535.

Trials.

The Gordon-Bennett French Eliminating Trials. An illustrated account of the trials to find out the best drivers and cars. 3000 w. Auto Jour—May 21, 1904. No. 63000 A.

The Gordon-Bennet French Eliminating Trials. An illustrated accounts of trials in France. 1800 w. Auto Jour—May 28, 1904. No. 63111 A.

See also Mechanical Engineering. Internal Combustion Motors.

HEATING AND COOLING.

Hot Water.

Description of Hot Water Heating Apparatus in the Schioldann Institution, Copenhagen, Denmark. A. B. Beck. Read before the Am. Soc. of Heat. & Ven. Engrs. Ills. 4500 w. Dom Engng—May 25, 1904. No. 63019 C.

Refrigeration.

The Ammonia Condenser. T. R. Wingrove. Discusses the various conditions which affect the circulation of the ammonia. Diagram. 1800 w. Ice & Refrig—June, 1904. No. 63069 C.

The Production and Applications of Artificial Cold (Production et Application du Froid Artificiel). F. Cottarel. A study of artificial refrigeration, with descriptions of some inportant installations. Four articles. 9000 w. 3 plates. Génie Civil—May 21, 28, June 4, 11, 1904. No. 63226 each D.

Ventilation.

Notes on the Plenum System of Ventilation. W. Herrman. Introducing a discussion before the Royal Institute of British Architects. 4600 w. Archt, Lond—June 10, 1904. No. 63425 A.

HYDRAULICS.

Air-Lift.

River Wells and the Horizontal Delivery of Water. G. C. H. Friederick. Calls attention to results obtained by the air-lift system of raising water. 1500 w. Engr, U S A—June 15, 1904. No. 63-403 C.

Centrifugal Pumps.

Centrifugal Pump Tests. Report of a series of exhaustive tests made by Professors William Kent and J. E. Denton, at the works of the De Laval Steam Turbine Co., Trenton, N. J., upon some of the smaller sizes of their principal types of centrifugal pumps. 3000 w. Ills. Jour Am Soc of Nav Engrs—May, 1904. No. 63468 H.

Some Tests of High-Speed Centrifugal Pumps. Condensed report of three tests made of different types of De Laval pumps. 3000 w. Eng News—June 2, 1904. No. 63079.

Hydraulic Stations.

The Proposed Law for Hydraulic Stations (Project de Loi pour les Usines Hydrauliques). An abstract of the regulations proposed for the utilization of watercourses in France. 2500 w. Revue Technique—June 10, 1904. No. 63234 D.

Pump.

Boiler-Makers' Hydraulic Machinery. The present article gives an illustrated description of pumps, the type shown being a set of three-throw horizontal belt-driven pumps. 1400 w. Prac Engr—June 2, 1904. Serial. 1st part. No. 63-362 A.

Pumping.

Deep-Well Pumping Machinery. W. Percy Guarani. Read before the Graduate's Sec. of the Inst. of Mech. Engrs. Considers the rotative and non-rotative engines used for deep-well pumping. Ills. 4000 w. Mech Engr—June 18, 1904. No. 63547 A.

INTERNAL-COMBUSTION MOTORS.

Benzol.

The Value of Benzol as a Motor Fuel. A report of investigations made, giving results. 4000 w. Autocar—May 21, 1904. No. 63004 A.

Diesel.

Internal Combustion Engines and the Diesel Principle. W. H. Booth. A study of the system of compression in the Diesel engine, showing its advantages. 1000 w. Elec Rev, Lond—June 10, 1904. No. 63433 A.

Fire Engines.

The Application of Petrol Motors to Fire-Engines. Illustrates the application to a fire-boat, and also to a motor-driven land engine, with descriptions. 1300 w. Engng—May 20, 1904. No. 63013 A.

Gas Engines.

The Steam Engine as a Competitor with the Gas Engine (Die Dampfmaschine im Wettbewerb mit der Gasmachine). M. E. Captaine. Showing the relative efficiencies at various loads and speeds. 3500 w. Zeitschr d Ver Deutscher Ing—May 28, 1904. No. 63218 D.

Oil Engines.

20-Horse-Power Diagonal Oil Engines for Launch. Illustrated description. 800 w. Engng—June 3, 1904. No. 63370 A.

Petrol Engine.

The Burchall Double-Acting Petrol Engine. Illustrates and describes an ingenious construction which apparently overcomes many of the disadvantages of the double-acting engines of the ordinary type. 3000 w. Auto Jour—May 28, 1904. No. 63113 A.

Rotary Valve.

A Rotary Induction and Exhaust Valve for Explosion Engines. Illustrates and describes a balanced rotary valve, introduced by Edward Butler, London, which controls both the functions of induction and exhaust of the gases to and from the motor. 1000 w. Sci Am Sup—June 18, 1904. No. 63386.

MACHINE WORKS AND FOUNDRIES.

Annealing.

Powdered Coal for Steel Annealing. H. J. Travis. Describes the pulverizing apparatus and gives the results of observations and tests of an annealing furnace using pulverized coal as fuel. Ills. 900 w. Am Mach—June 16, 1904. No. 63380.

Borings.

The Use of Cast-Iron Borings. A. E. Outerbridge, Jr. Facts from the writer's experience concerning the smelting of cast-iron borings. 1300 w. Foundry—June, 1904. No. 63321.

Comparison.

The Law of Comparison in Engineering Structures. W. F. Durand. Describes the method used in investigating the relation between the characteristic dimensions and the output of operation, illustrating by examples. 4000 w. Sib Jour of Engng—June, 1904. No. 63390 C.

Core Bench.

The Core Bench. Benjamin D. Fuller. Read before the Am. Found. Assn. Discusses the management of the core bench. 800 w. Ir Trd Rev—June 9, 1904. No. 63163.

Cranes.

Some examples of Present Practice in Cranes and Lifting Machinery. Edward C. R. Marks. An illustrated description of various types. 1200 w. Prac Engr—May 20, 1904. Serial. 1st part. No. 63-005 A.

Travelling Shipyard Crane at Vulcan Works, Bredon, Stettin. Illustrated description of an electric crane of great size designed for transporting armor plates and other heavy parts from the rolling-mill to the ships. 600 w. Engng—May 20, 1904. No. 63012 A.

Cutter Grinder.

The Becker-Brainard No. 1 14-inch Cutter and Reamer Grinder. Illustrates and describes a new machine able to handle various styles and sizes. 900 w. Ir Age—June 30, 1904. No. 63582.

Dividing Table.

A Large Dividing Table. H. G. Knoderer. Illustrated description. 1200 w. Amer Mach—June 23, 1904. No. 63507.

Drafting.

The Drafting Department as a Factor in Economical Shop Management. L. D. Burlingame. With numerous illustrations of the drafting rooms of important works and a discussion of the conditions of efficient operation. 3000 w. Engineering Magazine—July, 1904. No. 63200 B.

Drafting Instrument.

The Eccentrolinead. M. S. Smith. Illustrated description of this instrument, showing its usefulness. 800 w. Mach, N. Y.—June, 1904. No. 63067 C.

Electric Driving.

Electric Power in Manufacturing Plants. Dugald C. and William B. Jackson. An illustrated article discussing points to be considered in determining the most economical and satisfactory means of distributing and applying the power. 5700 w. Cassier's Mag—June, 1904. No. 63527 B.

Expanding.

Modern Expanding and Flanging Machinery and Tools—Luther D. Lovekin. Illustrates and describes machinery for expanding pipe into flanges. 2000 w. Jour Fr Inst—June, 1904. Serial. 1st part. No. 63341 D.

Fan Blowers.

Cupola Fan Practice. W. H. Carrier. Abstract of paper read before the Am. Found. Assn. Gives data relative to the operation of centrifugal blowers for cupola service, including the air supply required per pound of coke used and per ton of iron produced, etc. 3500 w. Ir Age—June 23, 1904. No. 63474.

Forming Tools.

Straight and Circular Forming Tools. Joseph M. Stabel. Illustrated description of the straight and circular forming tools used on screw machines. 2200 w. Mach, N. Y.—June, 1904. No. 63063 C.

Foundries.

Some Types of Modern Foundries. Illustrates and describes three modern foundries recently visited in the United States. 2000 w. Ir & Coal Trades Rev—June 17, 1904. No. 63500 A.

The Electrical Equipment of a Modern Type Foundry. Illustrated description of the plant of the American Type Founders' Company, Jersey City, N. J. 3500 w. Elec Rev, N. Y.—June 25, 1904. No. 63506.

Foundry Appliances.

Labor Saving Suggestions for the Foundry. H. F. Frohman. Read before the Am. Foun. Assn. Describes minor articles generally overlooked. 1200 w. Ir Trd Rev—June 9, 1904. No .63162.

Gear Cutters.

The Flather Gear Cutter. Illustrates and describes a new line of gear cutters, designed for the rapid production of spur gears. 900 w. Ir Age—June 30, 1904. No. 63583.

Gear Planer.

The Gleason 15-inch Shearing Cut Bevel Gear Planer. Illustrations, with detailed description. 800 w. Ir Age—June 23, 1904. No. 63471.

Green Sand.

Standard Methods for Green Sand

Beds. Thomas D. West. Read before the Am. Found. Assn. Discusses leveling straight edges to make a bed, making soft beds, method of testing the hardness of beds, how to designate kinds of beds, making hard beds and semi-hard beds for prickered plates. 6000 w. Ir Trd Rev—June 16, 1904. No. 63397.

Grinding.

A Talk on the Disk Grinder. F. N. Gardner. Considers the disk grinder with special reference to tool room work. 3500 w. Mach, N. Y.—June, 1904. No. 63,068 C.

The Grinding Machine as a Metal-Cutting Tool. C. H. Norton. An examination of the recent development of the grinding machine for sizing cylindrical parts, with illustrations of machines and products. 2500 w. Engineering Magazine—July, 1904. No. 63287 B.

Inspection.

See Industrial Economy.

Lathes.

Lathe Building Methods Used at the Works of the Lodge & Shipley Machine Tool Company. C. F. Pease. An illustrated article describing heavy casting cleaning, erecting department appliances, and stock boxes. 600 w. Am Mach—June 23, 1904. No. 63508.

Testing a Lathe. Oscar E. Perrigo. Considers particularly the inspection of the ordinary screw-cutting engine lathe, giving such description and illustrations of the necessary apparatus and methods as will insure the degree of accuracy demanded. 2000 w. Am Mach—June 2, 1904. No. 63055.

Machine Driving.

Power Transmission in Works. W. E. Buck. A discussion of the respective merits of electrical and mechanical methods for transmitting power to the machines. Two articles. 4000 w. Engr, Lond—June 3, 10, 1904. No. 63375 A.

Metal Cutting.

Advanced Practice in Economical Metal Cutting. Charles Day. A discussion of the relation of the high-speed steels to the machine tools in which they are used, showing the necessity for a consideration of all the details of the subject. 5000 w. Engineering Magazine—July, 1904. No. 63286 B.

The New Taylor-Newbold Metal Cutting Saw. Describes tests made at Philadelphia. Ills. 1200 w. Am Mach—June 16, 1904. No. 63381.

Milling Machine.

Fly-Wheel Milling Machine. Illustrates and describes a machine having features of special interest involving the discovery of a novel principle in the use of large face cutters. 1600 w. Engr, Lond—June 3, 1904. No. 63374 A.

Molding.

Crush of the Mold. William Leary. Considers the causes and remedies. 1000 w. Foundry—June, 1904. No. 63320.

Molding Machines. George C. Neilsen. From a paper before the Chicago Foundry Foremen's Assn. On the advantages and economy of these machines. 1400 w. Am Mach—June 9, 1904. No. 63171.

Molding Machines and and Their Use. E. H. Mumford. Read before the Am. Found. Assn. Calls attention to a few of these machines, with general remarks on their use. 1500 w. Ir Trd Rev—June 16, 1904. No. 63398.

Patterns.

Pattern-Making in Relation to Foundry Costs. W. H. Parry. Read before the Am. Found. Assn. Discusses the methods in use and their shortcomings. 1100 w. Ir Trd Rev—June 23, 1904. No. 63-503.

Planing Machine.

New 60-inch Portable Rotary Planing Machine. Emile Guarini. Brief description, with illustration, of an interesting machine manufactured in Philadelphia. 300 w. Prac Engr—June 10, 1904. No. 63429 A.

Pneumatic Tools.

Compressed Air and Pneumatic Tools in Railroad Service. Thomas Aldcorn. Suggestions for the care of tools, discussing the uses to which they are applied, the troubles met with, etc. General discussion follows. 8000 w. Pro Cent Ry Club—May 13, 1904. No. 63584 C.

Scrap Iron.

Scrap Iron Specifications. W. G. Scott. Read before the Am. Found. Assn. Gives a general classification of the material known as "foreign scrap," which in many cases is purchased by specification. 5000 w. Ir Trd Rev—June 16, 1904. No. 63-399.

Screw Machine.

Automatic Screw Machine. Illustrated description of a recent design. 1000 w. Am Mach—June 23, 1904. No. 63509.

Screw-Threads.

A Screw-Thread Angle Table. George L. Colburn. A table giving the angle of helixes of various pitches and diameters with respect to a line perpendicular to the axis, with explanatory notes. 500 w. Am Mach—June 9, 1904. No. 63173.

Shafts.

A Great Feat in Shaft Straightening. Describes the method used in straightening the tail shaft of the "Illinois." Ills. 800 w. Am Mach—June 2, 1904. No. 63054.

Sheet Metal.

Forming Sheet Metal Parts, Using Water as a Medium. Wartard Stark. Describing the use of water as a medium for forcing the metal into the die of a drop press. 700 w. Am Mach—June 30, 1904. No. 63580.

Shop Design.

Works Design as a Factor in Manufacturing Economy. Henry Hess. A study of machine shop arrangement, based upon an actual example and illustrated with views of many important establishments in Europe and America. 4500 w. Engineering Magazine—July, 1904. No. 63284 B.

Shops.

The Gutehoffnungs Works at Oberhausen (Die Gutehoffnungshütte bei Oberhausen). B. Osann. An historical and descriptive account of this famous works. Two articles. 9,000 w. 3 plates. Stahl u Eisen—April 15, May 1, 1904. No. 63269 each D.

The New Structural and Car Shops of the Cambria Steel Company, Johnstown, Pa. History of the plant, with illustrated detailed description. 4200 w. Eng Rec—June 18, 1904. Serial. 1st part. No. 63418.

The Shops of the Jones & Lamson Machine Company. Illustrates and describes the new building and the present arrangement of this plant for building turret lathes; located at Springfield, Vermont. 3000 w. Am. Mach. June 2, 1904. No. 63053.

The Witton and Holford Works of Kynoch, Limited. Illustrated description of works for the manufacture of cartridges and ammunition, and the trades bearing upon this industry. 5000 w. Engng—May 20, 1904. No. 63011 A.

Spindles.

Spindle Construction. Howard P. Fairfield. A detailed discussion of modern methods of making spindles for drill presses and other machine tools. Ills. 2200 w. Mach, N Y—June 1904. Serial. 1st part. No. 63064 C.

Tool Rooms.

The Tool Room and Its Functions in Cost Reduction. John Ashford. An exhaustive study of the equipment and functions of the modern tool room of the well-arranged machine shop, with numerous illustrations of rooms and tools. Serial. Part I. 4500 w. Engineering Magazine—July, 1904. No. 63285 B.

Tools.

Comments on Drives for High-Speed Cutting Tools. C. E. Coolidge. Remarks on modern tools, giving calculation of cutting force on tool and speed of belt. 1700 w. Mach, N Y—June, 1904. No. 63061 C.

Turret Lathes.

Some Points in Connection with the Manufacture of a Turret Lathe—The Use of Compressed Air in Jigs and Fixtures. An illustrated article describing interesting appliances designed for use in the manufacture of turret lathes. 2500 w. Am Mach—June 16, 1904. No. 63379.

The Flat Turret Lathe with Cross Feeding Head. An article showing something of the mechanism by which the spindle and chuck are driven, the head and carriage fed, and the unique movements in general made possible. Ills. 3400 w. Am Mach—June 30, 1904. No. 63578.

MATERIALS OF CONSTRUCTION.

Alloys.

Alloys of Copper and Arsenic. Arthur H. Hiorns. Discussion of this paper before the Faraday Society. 1200 w. Elec-Chem & Met—May, 1904. No. 63337 C.

Appendix IV. to Sixth Report of the Alloys Research Committee. Dr. William Campbell. A summary of various papers by Sir William Roberts-Austin on the effects of strain and of annealing in aluminum, antimony, bismuth, cadmium, copper, lead, silver, tin and zinc. 8000 w. Ills. Trans Am Soc of Mech Engrs. No. 041—June, 1904. No. 62992 C.

Brass.

The Influence of Heat upon the Strength of Durana Metal (Warmzerreissversuche mit Durana Gussmetall). Prof. R. Stribeck. Data and results of tests upon an alloy of copper, zinc, tin and lead, showing the loss of strength with increased temperature. 3000 w. Zeitschr d Ver Deutscher Ing—June 11, 1904. No. 63224 D.

Brittleness.

A Proposed Test for Detecting Brittleness in Structural Steel. J. P. Snow. Read before the Am. Soc. for Test, Materials. Proposes a nicked bending test on crop ends of plates and shapes as they are trimmed at the rolling-mill for shipment. 2500 w. Ir Age—June 23, 1904. No. 63479.

Carborundum.

Carborundum: Its Manufacture and Uses. R. N. Kofoid. Reviews the history of the discovery, describes the manufacture and some of the uses to which it has been applied. 5700 w. Technograph, No. 18, 1903-4. No. 63311 D.

Cast Iron.

Cast Iron, Strength, Composition, Specifications. W. J. Keep. Shows strengths and chemical composition graphically and gives facts based on extensive tests. 5500 w. Trans Am Soc of Mech. Engrs, No. 029—June, 1904. No. 62990 C.

The Engineer in the Foundry. R. Moldenke. Calls attention to facts about cast iron that engineers would find it well to know. 2400 w. Am Mach—June 30, 1904. No. 63581.

Corrosion.

The Behaviour of Certain Metals in Sea Water (Das Verhalten einiger Metalle im Seewasser). H. Diegel. A report of investigations upon the corrosive action of sea water upon copper, nickel and iron alloys. Two articles. 12,000 w. Stahl u Eisen—May 15, June 1, 1904. No. 63277 each D.

Corrosion of Metals. J. F. Buchanan. Reviews the relative position of the more useful metals and alloys to corrosion, considering preventives and describing some experiences in brass-founding. 2200 w. Foundry—June, 1904. No. 63519.

Metallography.

The Effects of Strain and Annealing in Aluminum, Antimony, Bismuth, Cadmium, Copper, Lead, Silver, Tin, and Zinc. Dr. William Campbell. An appendix to the 6th report to the Alloys Research Committee. Ills. by 16 plates. 7500 w. Inst of Mech Engrs—June, 1904. No. 63-334 D.

Paints.

Paints Suited for Engineering Structures. Gives information concerning the composition, chemical and physical properties of paints in general use. 1700 w. Engr, Lond—May 27, 1904. Serial. 1st part. No. 63138 A.

Protection of Metal Parts. H. M. Butts. Report on the advancement that has been made in paints for the protection of metal parts, and particularly steel cars. 1500 w. Pro Cent Ry Club—May 13, 1904. No. 63585 C.

Ropes.

Ropes of Vegetable Fiber. Charles W. Comstock. Considers the various materials used, methods of manufacture and treatment, strength and durability under different conditions, &c. 3300 w. Mines & Min—June, 1904. No. 63143 C.

Sheet Steel.

The Commercial Testing of Sheet Steel for Electrical Purposes. C. E. Skinner. Read before the Am. Soc. of Test. Materials. Describes methods of testing in daily use which have been found satisfactory, and capable of giving valuable results from an investigation standpoint. Ills. 3000 w. Ir Age—June 23, 1904. No. 63472.

Specifications.

The Influence of Specifications on Commercial Products. C. B. Dudley. Address before the Am. Soc. of Test. Materials. Considers the influence of the consumer, and the various phases of the stimulating effect of specifications. 3800 w. Ir Age—June 23, 1904. No. 63478.

Steel Castings.

The Technics of Steel Castings (Stahlformguss und Stahlformgusstechnik). Bernhard Osann. A general discussion of the methods and processes of making steel castings. Serial. Part I. 3000 w. Stahl u Eisen—June 1, 1904. No. 63280 D.

Steels.

Allov Steels. William Metcalf. Read before the Am. Soc. of Test. Materials. Considers nickel steel, manganese steel, self-hardening or air hardening steel, and high-speed steel. 2000 w. Ir Age—June 23, 1904. No. 63473.

Testing.

Bending Tests of Rolled and Riveted Beams (Biegeversuche mit Gewalzten und mit Genieteten Trägern). F. Schüle. With illustrations of the Amsler-Laffon testing machine, and data and results of tests, with especial reference to the Grey beam. Two articles. 3,500 w. Schweiz Bauzeitung—May 21, 28, 1904. No. 63-260 each B.

Tool Steels.

High-Speed Tool Steels. Walter Brown. Gives interesting experiences that were successful. 1500 w. Am Mach—June 2, 1904. No. 63056.

High-Speed Tool Steels. Walter Brown. Practical suggestions for their treatment. 1500 w. Mach, N Y—June, 1904. No. 63066 C.

Treatment of Crucible Cast Tool Steel, with Chemical Composition of High-Speed Steel. Richard H. Probert. Read before the Ohio Soc. of Mech., Elec. & Steam Engrs. 3200 w. Engr, U S A—June 15, 1904. Serial. 1st part. No. 63-402 C.

MEASUREMENT.

Air Resistance.

A Comparison of the Resistance of the Air to Various Forms of Balloons (Comparaison des Résistances Directes de Diverse Carènes Aeriennes). Ch. Renard. An application of the author's dynamometer to the determination of the coefficients of atmospheric resistance. The law of the square of the velocity is verified. 1500 w. Comptes Rendus—May 24, 1904 No. 63254 D.

Experiments upon the Resistance of the Air (Recherches Relatives à la Resistance de l'Air). Ch. Renard. A description of the Renard dynamometric balance, and its application to the measurement of atmospheric resistance. 1200 w. Comptes Rendus—May 16, 1904. No. 63252 D.

The Air Vane Dynamometer of Col. Ch. Renard (Das Windflügel-Dynamometer des Obersten Ch. Renard). F. Ross. An account of the use of the apparatus in testing automobile motors. 2000 w. Zeitschr f Elektrotechnik—May 29, 1904. No. 63265 D.

Gauges.

Dimension Limits and Limit Gauges, Their Practical Uses and Results. Arthur A. Fuller. Showing the intelligent use of the limit gauge to lie at the foundation of standardizing and interchangeable systems, giving practical examples. 3000 w. Engineering Magazine—July, 1904. No. 63288 B.

Graphostatics.

The Decomposition of Forces (Ueber Kräftezerlegung). A. Kiefer. Giving solutions of a number of special problems in graphical statics. 1800 w. Schweiz Bauzeitung—May 21, 1904. No. 63261 B.

Locomotive Testing.

Locomotive Testing Plants. W. F. M. Goss. Illustrates and describes the plants at Purdue University and the plants of the Chicago & Northwestern Railroad Co., Columbia University, the Pennsylvania Railroad System at St. Louis, and of other experimenters. 8000 w. Trans Am Soc of Mech Engrs, No. 043—June, 1904. No. 62994 C.

Locomotive Testing Plant at the St. Louis Exhibition. H. W. Hanbury. Indicates the principle upon which the plant is based, and explains the difficulties in connection with the installation which have delayed its completion. Ills. 2200 w. Engng—June 17, 1904. No. 63498 A.

I. Testing Locomotives in England. G. J. Churchward. Describes the testing plant on the Great Western Railway at Swindon. II. Measured Tests in Service. W. F. Pettigrew. On the instruments and results required at a test. 2700 w. Inst of Mech Engrs—June, 1904. No. 63335 D.

Slide Rule.

An Instrument for Use with Screw-Cutting Lathes (Sur un Instrument Destiné à Faciliter l'Emploi du Tour à Fileter). M. Moehlenbruck. A form of circular slide rule with double runner, enabling the various change gears for screw-cutting to be selected without computation. 800 w. Comptes Rendus—May 24, 1904. No. 63255 D.

Spring Testing.

An Important Test of Elliptic Springs. S. A. Bullock. Describes tests made for the Interborough Rapid Transit railway to determine permanent set and proper working fiber stress. 800 w. Am Engr & R R Jour—June, 1904. No. 63158 C

Testing Laboratory.

See Industrial Economy.

Tool Dynamometer.

Experiments with a Lathe-Tool Dynamometer. J. T. Nicholson. A record of results of over 300 serial trials, each requiring the making, recording and reducing of from 50 to 100 observations. Ills. 8500 w. Inst of Mech Engrs—June, 1904. No. 63329 D.

Experiments with a Lathe-Tool Dynamometer. J. T. Nicolson. A record of results of over 300 serial trials as the first installment of work required to give an understanding of the action of the tools used in a machine shop. 7500 w. Trans Am Soc of Mech Engrs. No. 040—June, 1904. No. 62991 C.

Weighing.

Typical Automatic Weighing Machines. Emile Guarini. Illustrates and describes machines made in England. 1500 w. Sci Am Sup—June 25, 1904. No. 63536.

POWER AND TRANSMISSION.

Compressed Air.

Tests of Air Compressors (Versuche an Luftkompressoren). Data and results of tests of single and double stage air compressors built by Meyer of Mülheim, with indicator diagrams, and valve details. 1200 w. Glückauf—May 28, 1904. No. 63-245 B.

The Air Compressor. R. H. Collingham. On the design of air compressors, indicating how theoretical facts and formulæ may be made of use in the every-day practice of the drawing office and testing plate. 1800 w. Engr, Lond—June 3, 1904. Serial. 1st part. No. 63371 A.

Joint.

The Efficiency of the Universal Joint (Sur le Rendement du Joint Universel). L. Lecornu. Deriving an equation showing the relation of the angle between the two shafts to the efficiency. 1200 w. Comptes Rendus—May 30, 1904. No. 63257 D.

Mechanical Plant.

The Arcade Building Power Plant, Dayton, O. An isolated mechanical equipment for power and lighting service, and also including an ice-making and cold-storage plant. Ills. 1700 w. Eng Rec—June 18, 1904. No. 63419.

Power Plant.

The Power Plant of Princeton University. A. M. Feldman. Brief illustrated description of a plant furnishing heat, light and power for the forty buildings of the university, and planned with a view to furnishing light and heat outside of the grounds. 1000 w. Engr, U S A—June 15, 1904. No. 63401 C.

Remodeled Plant.

Remodeled Studebaker Power Plant at

South Bend, Indiana. Brief illustrated description of the changes made. 1800 w. Eng Rec—June 25, 1904. No. 63560.

Ropes.

Notes on Rope Transmission. E. A. Reuleaux. Notes and tables on the American system of rope transmission only. 1600 w. Am Mach—June 9, 1904. No. 63172.

STEAM ENGINEERING.

Boilers.

The Belleville Boilers. L. Fauveau. Translated from the French. Illustrates and describes the present Belleville boiler, and gives the history of the various stages through which it has passed. 3500 w. Jour Am Soc of Nav Engrs—May, 1904. No. 63466 H.

Corrosion.

Corrosion of Boiler Tubes. John D. Ford. A report of experimental tests to ascertain the relative corrodibility of lap-welded Bessemer steel, lap-welded, iron, seamless cold-drawn steel, and seamless hot-drawn steel boiler tubes. Ills. 4500 w. Jour Am Soc of Nav Engrs—May, 1904. No. 63467 H.

Economizers.

Economizer Calculations. W. H. Booth. Discusses the action of economizers and methods of determining the efficiency. 1300 w. Power—June, 1904. No. 63-050 C.

The Efficiency of Fuel Economizers. George E. Walsh. A statement of the advantages and economy that should be expected by using economizers. 1800 w. Ir Trd Rev—June 2, 1904. No. 63060.

Engines.

Early Steam Engines. A. R. Bell. An illustrated article considering some of the earliest work of inventors. 1800 w. Mach, N Y—June, 1904. No. 63062 C.

New Hamilton-Corliss Vertical Cross Compound Engine. Illustrated detailed description of a new design. 1200 w. St Ry Jour—June 18, 1904. No. 63451 C.

Entropy.

The Entropy Diagram and Its Uses. H. Boyd Brydon. Explains its use in determining just what an engine is doing, its losses, where they are, and the effect of any changes made. 4300 w. Power—June, 1904. No. 63051 C.

Expansion.

Steam Curves. W. H. Booth. A discussion of the curves used to show the action of expanding steam. 1800 w. Elec Rev, Lond—May 27, 1904. No. 63115 A.

Explosions.

A Disastrous Boiler Explosion. Illustrated description of the terrible explosion in St. Louis on the 21st of last December, when seven water-tube boilers exploded simultaneously. Discusses the cause. 2500 w. Locomotive—April, 1904. No. 63424.

Steam Boiler Insurance. A. D. Risteen. Extracts from a lecture in the Yale Insurance Course. Considers the cause and prevention of explosions, the risks, testing, &c. 6000 w. Ir Trd Rev—June 9, 1904. No. 63164.

Feed Pumps.

Air Chambers on the Water Supply Inlets of Boiler Feed Pumps. Walter T. Ray. An illustrated description of an investigation into the cause of excessive hammering of three boiler-feed pumps in the Harrison street station of the Chicago Edison Co. 2000 w. Technograph, No. 18—1903-4. No. 63315 D.

Feed-Water.

Impure Feed-Water in Boilers. C. W. U. Adamson. Considers briefly substances in solution, salts in solution, free acids, air and other gases and oil, and indicates the general methods employed to remove them. 1800 w. Aust Min Stand —April 14, 1904. Serial. 1st part. No. 63125 B.

Purification and Automatic Feeding of Boiler Water (Wasserreinigung und Automatische Speisung). Illustrating several forms of lime and soda softeners, as well as the Körting automatic boiler feeder. 1200 w. Glückauf—June 4, 1904. No. 63248 B.

Softening and Purification of Water. J. C. W. Greth. Notes the kinds of impurities, considering some of the mechanical devices and methods employed in the purification for boiler-feed purposes, showing them to be only partially successful, and discusses the advantages of the intermittent settling tank system. General discussion. 900 w. Pro Engrs' Soc of W Penn—Feb, 1904. No. 63389 D.

Water Softening on the Southern Pacific. H. Stillman. Gives a mechanical description of the apparatus used, with illustrations. 2000 w. R R Gaz—June 24, 1904. No. 63522.

Water-Softening on the Union Pacific. A. K. Shurtleff. Gives an account of the steps taken to improve the water on a division of this road, and the results obtained. 2500 w. R R Gaz—June 24, 1904. No. 63521.

Feed-Water Heater.

A Home-made Boiler Feed Water Heater. Ernest Stein. Illustrated description. 600 w. Eng & Min Jour—June 23, 1904. No. 63513.

Exhaust Steam Boiler Feed-Water

Heaters; Hot Water Pumps and Pumping. W. D. L. Hardie. Read before the Can. Min. Inst. Discusses the objects of feed-water heaters, reviewing the progress and giving information from the writer's experience. Ills. 5000 w. Can Min Rev —May 31, 1904. Serial. 1st part. No. 63072 B.

Firing.

Coal Firing in Full Depth Regenerator Furnaces. G. W. McKee. Describes experiments made with the view of ascertaining in what way the consumption of fuel might be lessened and the efficiency of the furnace maintained. 1600 w. Pro Age—June 1, 1904. No. 63057.

Flow.

The Flow of Steam Through Nozzles. A. M. Levin. Gives a method for the solution of problems relating to this subject. 2000 w. Am Mach—June 30, 1904. No. 63579.

Hammers.

Notes on the Design of Steam Hammers. W. M. Park. Gives a rational solution of some of the mechanical problems involved in the design. 1600 w. Technography, No. 18—1903-4. No. 63312 D.

Mechanical Stokers.

The Mechanical Stoker and the Human Operator. Edwin Yawger. Presents some of the general considerations that bear on the art of combustion of fuel in boiler furnaces. 3000 w. Am Gas Lgt Jour—June 20, 1904. No. 63447.

Outflow.

Experiments on the Outflow of Steam. Prof. M. F. Gutermuth. Translated from the *Zeitschrift des Vereines Deutscher Ingenieure.* An account of experiments at the mechanical laboratory of the Technical High School at Darmstadt on the outflow of steam through openings of various cross-sectional shapes. Ills. 4500 w. Jour Am Soc of Nav Engrs—May, 1904. No. 63469 H.

Pipe Coverings.

Note on the Relative Efficiency of Heat Insulating Media. S. H. Davies. An account of experimental investigations with the object of finding a suitable covering for pipes conveying highly superheated steam. 1600 w. Engr, Lond—May 27, 1904. No. 63139 A.

Steam Pipe Covernigs. S. H. Davies. From the *Jour of the Soc. of Chem. Ind.* Results of an interesting series of experiments made by S. H. Davies. 2000 w. Mech Engr—June 4, 1904. No. 63363 A.

Reversing Gear.

The Norberg Reversing Gear. R. A. Wright. A description of the reversing gear of a large mine hoisting engine. 600 w. Am Mach—June 9, 1904. No. 63170.

Speed Regulation.

Notes on Fly-Wheels. H. H. Barnes. Jr. An outline of comparative tests of generating sets with both light and heavy fly-wheels, discussing the effect upon the uniformity of speed. 4000 w. Trans Am Inst of Elec Engrs—May 17, 1904. No. 63343 D.

The Obscure Cause of Failure of a Corliss Engine Governor to Regulate. Yestric Land. Explains the conditions and the difficulty in locating the trouble, with the final success. 1600 w. Am Mach —June 9, 1904. No. 63169.

Steam Ports.

On Port Areas for Steam Engines. M. F. Gutermuth. Translated from the *Zeitschrift des Vereines Deutscher Ingenieure.* An illustrated study of the behavior of the flow of steam and the influence of the point of cut-off upon the proportions of steam passages. 3500 w. Jour Am Soc of Nav Engrs—May, 1904. No. 63470 H.

Superheating

Superheated Steam. F. J. Rowan. Read before the Inst. of Engrs. and Shipbuilders. Reviews the history of the various investigations made in this field since 1736, describing designs of superheaters. 3500 w. Sci Am Sup—June 18, 1904. No. 63385.

The Specific Heat of Superheated Steam (Die Spezifische Wärme des Ueberlutzten Wasserdampfes). H. Lorenz. Describing investigations made at the Institute of Technical Physics at Göttingen, showing the specific heat of superheated steam to be about 0.6. 2000 w. Zeitschr d Ver Deutscher Ing—May 14, 1904. No. 63213 D.

Turbines.

Brake Tests of a 400-kw Westinghouse-Parsons Steam Turbine. Gives interesting results of a series of tests made at East Pittsburg, Pa. 1500 w. St Ry Jour —June 11, 1904. No. 63302 C.

Different Applications of Steam Turbines. A. Rateau. An account of the practical results of the writer's work in this field, describing the Rateau turbine, and giving results of various applications. Ills. 9500 w. Inst of Mech Engrs—June, 1904. No. 63330 D.

Dynamic and Commercial Economy in Turbines. Robert H. Smith. The present article discusses the fundamental principles of turbines and the applications of these principles to steam or gas turbines. 3000 w. Engr, Lond—May 27, 1904. No. 63137 A.

Fitness of the Steam Turbine for Heavy Power Service. From a paper by J. R.

Bibbins, read before the New England R. R. Club. Discusses the general principles, construction, &c. Ills. 4000 w. Ry and Engng Rev—May 28, 1904. Serial. 1st part. No. 63036.

Notes on the Steam Turbine. H. F. Schmidt. On the losses in a steam turbine, based on a study of the various curves, showing the results of tests, and attempting to find out the reason that the total steam consumption curve for all turbines is, for all practical purposes, a straight line. 2500 w. St Ry Jour—June 25, 1904. No. 63565 C.

The Rateau Steam Turbine. Walter Rappaport. Explains the action of the steam in various types of turbines, and claims that the Rateau turbine avoids the drawbacks shown in other types, describing and stating the advantages. Ills. 1200 w. Elec Rev, Lond—June 17, 1904. No. 63542 A.

The Steam Turbine as Applied to Electrical Engineering. Charles A. Parsons, G. Gerald Stoney and C. P. Martin. Paper read before the Inst. of Elec. Engrs. Reviews the development of the steam turbine, giving reports of tests made, and discussing the improvements effected. 4000 w. Elect'n, Lond—May 27, 1904. Serial. 1st part. No. 63119 A.

The Steam Turbine in Modern Engineering. W. L. R. Emmet. Gives a comparison of the Parsons and DeLaval types, and describes the Curtis turbine, giving illustrations. 2800 w. Trans Am Soc of Mech Engrs, No. 042—June, 1904. No. 62993.

The Turbine: A New Era of Steam. Arthur Warren. An illustrated article calling attention to the great advance, and the changes it is making in the engineering world. 3800 w. Rev of Revs—June, 1904. No. 63308 C.

The Zoelly Steam Turbine (Die Dampfturbine von Zoelly). J. Weishäupl. Detailed description of the machine, and data and results of tests. 3000 w. Zeitschr d Ver Deutscher Ing—May 14, 1904. No. 63212 D.

The Zoelly Steam Turbine. Illustrated description of a steam turbine of the multi-stage impulse type, in which the expansion of the steam takes place in the passages in the stationary parts of the apparatus. 2000 w. Eng Rec—June 4, 1904. No. 63100.

MISCELLANY.

Aeronautics.

The Critical Speed of Dirigible Balloons (Sur la Vitesse Critique des Ballons Dirigeables). Ch. Renard. An examination of the relation of speed to stability, showing the influence of the form and size of the balloon. 1500 w. Comptes Rendus—June 6, 1904. No. 63259 D.

The Best Inclinations for the Surfaces and Propeller Shafts of Dynamical Air Ships. Excerpt of a paper read by T. W. K. Clarke before the Aeronautical Inst. The subject is treated from a mathematical and theoretical standpoint, with the object of showing the considerations affecting the efficiency. 2000 w. Auto Jour—June 11, 1904. No. 63427 A.

Pendulum Systems.

Foucault Pendulum Systems. Ernest K. Adams. Describes a variety of Foucault pendulum suspension that might be tried for maintaining the swings of the pendulum indefinitely. Ills. 5600 w. Elec Wld and Engr—June 25, 1904. No. 63551.

MINING AND METALLURGY

COAL AND COKE.

Analysis.

A Neglected Factor in Coal Analysis. S. W. Parr. Shows the error in regarding the ash and moisture as the inert substance, and the volatile matter and fixed carbon as the true combustible, proposing a possible remedy. 900 w. Technograph, No. 18—1903-4. No. 63313 D.

Coal Tipples.

The Use of Steel for Coal Mine Tipples. George S. Rice. Abstract of a paper read before the W. Soc. of Engrs. A discussion of tipple construction, and the reasons why steel is better than wood; the vibrations caused by the introduction of shaking screens, &c. Constructional features are considered in detail. Ills. 3000 w. Eng News—June 16, 1904. No. 63409.

Coke.

The Structure of Coke and Its Applications in the Foundry (Der Koks, seine Struktur und seine Verwendung zu Giessereizwecken). Friedrich Schreiber. A study of foundry coke, with especial reference to the effect of the method of coking upon the product. 2500 w. Stahl u Eisen—May 1, 1904. No. 63275 D.

Coking.

The Coking of Hard Coal (Zur Frage

der Steinkohlenverkokung). Oscar Simmersbach. An examination of the behaviour of coal in the operation of coking, with especial reference to the nature of the coal. 3500 w. Stahl u Eisen—April 15, 1904. No. 63270 D.

Collieries.

The Eureka Collieries. An illustrated article summarizing the present methods and equipment of ten mines in Pennsylvania, near Johnstown. 2000 w. Eng & Min Jour—June 2, 1904. No. 63073.

Colorado.

The Primero Mines. R. M. Hosea. An illustrated description of the extensive plant of the Colorado Fuel & Iron Co. for the mining and coking of coal. 4800 w. Mines & Min—June, 1904. No. 63-142 C.

Electric Power.

Electricity in Colliery Work. F. J. A. Matthews. Considers in detail the application of electricity to colliery work, the methods of transmission of power, &c. Ills. 3700 w. Mech Engr—June 18, 1904. Serial. 1st part. No. 63545 A.

Electric Power in European Collieries. C. S. Vesey Brown. Gives illustrations showing typical engine rooms of the colliery plants, and motor drives, describing the working at various mines, and giving an account of the development. 2500 w. Cassier's Mag—June 1904. No. 63534 B.

Nevada.

A Nevada Coal Field. W. J. Stoneham. Describes a recently discovered coal field, the work done, the character of the coal, &c. 1000 w. Eng & Min Jour—June 23, 1904. No. 63514.

Peat.

Investigations upon the Value of Peat (Versuche über die Verwertung des Torfes). Dr. L. C. Wolff. Determinations of the calorific value of peat together with the available by-products obtained by coking. 3500 w. Zeitschr d Ver Deutscher Ing—June 11, 1904. No. 63222 D.

Preparation.

Coal Preparation at the Düsseldorf Exposition of 1902 (Ueber die Kohlenaufbereitung auf der Düsseldorfer Ausstellung 1902). C. Blömeke. Describing a number of systems and devices for washing, screening and classifying coal. Two articles, 6000 w. 1 plate. Oesterr Zeitschr f Berg u Hüttenwesen—June 4, 1904. No. 63240 each D.

The New Coal Washing Plant at the Röchlingen Works at Völklingen (Die Neue Kohlenwäsche der Röchlingen Eisen und Stahlwerke in Völklingen). An illustrated description of a recent installation, with results of the preparation of coals of the Saar district, Prussia. 2500 w. Glückauf—May 21, 1904. No. 63-242 B.

The New Separation and Washing Plant of the Dahlbusch Mine (Die Neue Separation und Wäsche des Schachtes VI. der Zeche Dahlbusch). Illustrating the screens, conveyors and general arrangement of the entire plant. 1200 w. 1 plate. Glückauf—June 4, 1904. No. 63247 B.

The Screening, Washing and Briquetting Plant at Alstaden (Siebrei, Wäsche, und Brikettfabrik der Aktiengesellschaft Alstaden). An illustrated description of a modern coal handling and preparing plant recently installed near Oberhausen. 2000 w. 1 plate. Oesterr Zeitschr f Berg u Hüttenwesen—May 14, 1904. No. 63-238 D.

Working.

Methods of Working Coal in the Rhenish Westphalian Basin. Abstract from a report by Maurice Bodart. Describes the characteristic features and the methods adopted. Ills. 4500 w. Ir & Coal Trds Rev—May 27, 1904. No. 63141 A.

COPPER.

Analysis.

The Analysis of Calcines. John P. Walker. An account of a new method of determining the chemical composition of calcined copper ores. 2000 w. Eng & Min Jour—June 9, 1904. No. 63175.

Arizona.

Diamond Drilling in an Arizona Copper District. Dwight E. Woodbridge. A report of the diamond drill work. 1100 w. Eng & Min Jour—June 2, 1904. No. 63077.

Southwestern Copper Developments. Dwight E. Woodbridge. A summary of the leading camps of Arizona and Northwestern Sonora, and a discussion of the future outlook. 5000 w. Ir Age—June 2, 1904. No. 63059.

Copper-Queen.

The Phelps-Dodge Copper Interests. Dwight E. Woodbridge. Information of interest in regard to the Copper-Queen and other property. 3500 w. Ir Age—June 23, 1904. No. 63475.

Deposits.

A Curious Copper Deposit. Arthur Lakes. Abstract from a paper by J. A. W. Murdoch, describing low-grade ore worked at a profit without capital in a waterless district; and also the perfect preservation of a human body by impregnation of copper salts, probably as old as 1600 A. D. 700 w. Min Rept—May 26, 1904. No. 63022.

Siemens Process.

Studies on Siemens' Process for Winning Copper. M. DeK. Thompson, Jr. Abstract of an investigation performed at the electrochemical laboratory of the Polytechnikum at Zurich. 6000 w. Elec-Chem Ind—June, 1904. No. 63570 C.

West Australia.

Copper Mining, Ravensthorpe (W. A.). Walter F. Smith. A description of this district and its mines. 3500 w. Aust Min Stand—April 28, 1904. No. 63365 B.

GOLD AND SILVER.

Arizona.

The Tombstone Mines, Arizona. On the work of re-opening the Tombstone mines. 1800 w. Eng & Min Jour—June 9, 1904. No. 63174.

British Columbia.

Summary Report on the Valley of the Flathead River. Description by the Provincial Mineralogist in the annual report of the Minister of Mines for 1903. Ills. 8800 w. B C Min Rec—June, 1904. No. 63195 B.

Cyanide.

An Industrial Method for the Determination of the Oxygen in Working Cyanide Solutions. A. Prister. Illustrated description of a method much simpler than those formerly used. 4000 w. Jour of Chem, Met & Min Soc of S Africa—April, 1904. No. 63007 E.

Cyaniding Gold-Bearing Sulphides. J. H. Burfeind. Gives particulars of results, considering the work of Professor Christy, and of Mr. Joseph Smith. 2500 w. Min Rept—June 23, 1904. No. 63553.

Dredge.

A Gold-Mining Dredge of Recent Design. Samuel S. Wyer. Illustrates and describes a dredge designed by the writer for work in Idaho, which presents unique features. 2000 w. Eng & Min Jour—June 9, 1904. No. 63176.

Fusion.

The Fusing Point of Gold (Sur le Point de Fusion de l'Or). Daniel Berthelot. A comparison of a number of measurements by the author and others, the latest determination being 1067.4 degrees C. 1200 w. Comptes Rendus—May 9, 1904. No. 63251 D.

Idaho.

The Silver City District, Idaho. A description of the mines and their development. Ill. 2000 w. Eng & Min Jour—June 2, 1904. No. 63075.

Indo-China.

The Mines of Bong Miu, Annam. Illustration, with description of the gold mines and methods of working. 1200 w. Min & Sci Pr—June 18, 1904. No. 63561.

Mercur.

The Geology of Mercur. George H. Dern. The history of the region with description of the gold and silver ores and their peculiar formation, discussing how they were deposited. Ills. 3800 w. Mines & Min—June, 1904. No. 63145 C.

Nicaragua.

Mining in Nicaragua. H. E. West. Brief account of the gold deposits and their working. 1100 w. Min & Sci Pr—June 18, 1904. No. 63562.

Quicksilver.

Quicksilver recovered in the Cyanide Process. E. J. Sweetland. Considers the manner in which it enters into the tailings and the recovery. 600 w. Min & Sci Pr—May 21, 1904. No. 63043.

Refining.

Electrolytic Refining of Gold. Emil Wohlwill. Notes on the writer's electrolytic method of refining gold, the advantages of the process, &c. 2200 w. Elec-Chem Ind—June, 1904. Serial. 1st part. No. 63569 C.

Sampling.

Notes on Mine Valuation and Sampling. A. W. Warwick. Briefly considers the various steps of mine valuation and correct sampling. 2000 w. Min Rept—May 26, 1904. No. 62023.

Silver-Lead.

The St. Eugene Mine. E. Jacobs. A description of this mine, which is the largest silver-lead producer in British Columbia. 1500 w. Eng & Min Jour—June 16, 1904. No. 63416.

Slimes.

The Decantation Process of Slimes Treatment: Its Possibilities and Limitations. E. J. Laschinger. Discusses this process under various given conditions, showing losses incurred by carrying certain factors in treatment beyond definite limits and indicating how best economic results may be obtained. 8500 w. Jour of Chem, Met & Min Soc of S Africa—April, 1904. No. 63006 E.

Solubility.

Solubility of Gold in Certain Oxidizing Agents. Victor Lenher. Abstract of an article in the *Jour.* of the *Am. Chem. Soc.* Describes a series of experiments made and the results. 1200 w. Eng & Min Jour—June 16, 1904. No. 63414.

Witwatersrand.

Observations on the Metallurgical Practice of the Witwatersrand. Harry S. Denny. A reply to the discussion on the writer's paper. 10000 w. Jour of Chem, Met & Min Soc of S Africa—April, 1904. No. 63008 E.

The Metallurgy of Gold on the Rand Gold-Fields. Clement Dixon and M. Torrente. Gives a résumé of the metallurgical practices in these fields, showing the development of the cyanide process. Also editorial. 9500 w. Elec-Chem Ind. June, 1904. No. 63568 C.

IRON AND STEEL.

Blast Furnaces.

A Furnace Charging and Distributing Apparatus. Frank C. Roberts. Illustrated description of apparatus designed by the writer with statement of its advantages. 1700 w. Ir Age—June 23, 1904. No. 63476.

Charcoal Furnace.

The Pioneer Charcoal Furnace and Chemical Plant. A description of an interesting exhibit at St. Louis Exposition of the Pioneer Iron Company, at Marquette, Mich. 3700 w. Ir Age—June 23, 1904. No. 63477.

Charging Machine.

Improved Electric Charging Machine (Elektrisch Betriebene Block-Einsetzmaschine). Illustrated description of a traveling machine for placing ingots in reheating furnaces. 2000 w. Stahl u Eisen —June 1, 1904. No. 63279 D.

Concentration.

Concentration of Mesabi Iron Ores. Dwight E. Woodbridge. An account of the experimental work being made by the Canisteo Mining Company, of Duluth, and describing the ore deposits. 1400 w. Eng & Min Jour—June 16, 1904. No. 63412.

Electric Smelting.

See Electrical Engineering, Electrochemistry.

Elevators.

Electric Elevators for Blast Furnaces (Elektrische Antriebe von Hochofenaufzuge). C. Schiebeler. With illustrations of details of electrically operated charging devices. 1800 w. Stahl u Eisen—April 15, 1904. No. 63271 D.

Hematite.

The Preparation of Brown Hematite Iron Ores. F. Lynwood Garrison. Explains the fundamental principle of log washers or trommels, and gives an illustrated description of a plant designed by the writer. 1100 w. Eng & Min Jour—June 16, 1904. No. 63413.

Hot Blast.

The Work of Faber du Faur in the Utilization of Furnace Gases (Faber du Faur und die Verwendung der Gichtgase). Ernst Baur. An historical review of the introduction of the hot blast into German blast furnaces. 2500 w. Stahl u Eisen—May 15, 1904. No. 63276 D.

Iron District.

Vermilion Iron-Bearing District of Minnesota. Kirby Thomas. A review of the fifth monograph on this region by the United States Geological Survey. Ills. 2200 w. Mines & Min—June, 1904. No. 63146 C.

Open Hearth.

Various Processes for the Production of Low Steel in the Open Hearth Furnace (Ueber Verschiedene Verfahren zur Erzengung von Flusseisen im Herdofen). R. M. Daelen. A review of recent improvements in open-hearth steel making, presented at the Düsseldorf Convention of the Verein Deutscher Eisenhüttenleute. 3000 w. Stahl u Eisen—May 1, 1904. No. 63273 D.

Review.

Twenty-five Years of German Iron Industry (25 Jahre Deutscher Eisenindustrie). E. Schroedter. Address at the convention of the Verein Deutscher Eisenhüttenleute, with diagrams showing the progress of the iron and steel industries of various countries. 4500 w. Stahl u Eisen—May 1, 1904. No. 63272 D.

Rolling Mills.

Recent Progress in Wire-Rod and Bar Rolling-Mill Plants. Considers recent practice in England, Germany and America. Ills. 2800 w. Engng—June 3, 1904. No. 63369 A.

The New Plate Rolling Mill of the Charlotten Works (Das Neue Blechwalzwerk der Charlottenhütte). A. Ruhfus. Illustrated description of the new works at Niederschelden on the Sieg. 1500 w. 1 plate. Stahl u Eisen—June 1, 1904. No. 63278 D.

Separation.

Magnetic Separation. F. T. Snyder. Read before the Can. Min. Inst. Remarks on the development of magnetic separation, the early types of separators, the present extensive use and the results. 3300 w. Can Min Rev—May 31, 1904. No. 63071 B.

Silicon.

The Influence of Silicon on Iron (Der Einfluss von Silizium auf Eisen). F. Wüst. With microphotographs, showing the nature of the various iron alloys, and tables of the physical properties. 2500 w. Stahl u Eisen—May 1, 1904. No. 63274 D.

MINING.

Boring.

The Choice of Methods for Deep Boring (Die Wahl der Bohrmethode für Tiefe Schurfbohrungen). Paul Stein. Comparing the relative value of the diamond and the percussion drill and showing the conditions governing the selection of a method. Two articles, 4000 w. Oesterr Zeitschr f Berg u Huttenwesen—May 21, June 4, 1904. No. 63239 each D.

Deposits.

Ore in Rocks of All Geological Periods. Arthur Lakes. Shows that ore depositions may be found in all rocks providing certain circumstances or conditions are present. Illustrates by examples. 1400 w. Min Rept—May 26, 1904. No. 63021.

Egypt.

Mining in Ancient Egypt. Abstract from the report of the Egyptian and Soudan Mining Syndicate. Reviews the ancient history of the mines, and their present condition. 2500 w. Min Rept—May 26, 1904. Serial. 1st part. No. 63024.

Explosives.

Nitro Explosives. Howard C. Parmelee. Describes these substances, explaining their action and analysis. 700 w. Min Rept—June 16, 1904. No. 63446.

Recent Explosives (Neue Sprengstoffe). Dr. Anton Mikolajczak. An examination of the nitro-glycerine series, with especial reference to the higher stability of dinitroglycerine. 1200 w. Glückauf—May 28, 1904. No. 63246 B.

Exposition.

Mining and Metallurgy at the Louisiana Purchase Exposition. Arthur H. Storrs. A short description of some of the exhibits. 3800 w. Mines & Min—June, 1904. No. 63147 C.

Faults.

Some Observations Concerning Faults. Arthur Lakes. An illustrated article explaining how faults are sometimes indicated on the surface, and other peculiarities. 700 w. Min Rept—June 2, 1904. Serial. 1st part. No. 63088.

Fires.

The Prevention and Extinction of Spontaneous Coal Fires in the Zwickau District (Die Entstehung, Verhütung, und Bekämpfung der durch Selbstentzundung von Kohle Hervorgerufenen Grubenbrände im Zwickauer Steinkohlenreviere). H. Brauns. A very complete account of practical methods of handling fires in coal mines. Three articles, 2 plates, 10000 w. Glückauf—May 28, June 4, 11, 1904. No. 63243 each B.

Hoisting.

A Comparison of Steam and Electric Power for Hoisting Machines (Vergleich der Betriebskräfte Dampf und Elektrizität für Fördermaschinenbetrieb). H. Laudien. Giving continuous diagrams of work, speed, resistance, etc., for mine hoists, with a summary of the extent to which the requirements are met by steam and electric motors. 3000 w. Glückauf—May 28, 1904. No. 63244 B.

Lamp.

The Bohres Electric Mine Lamp (Bohres' Elektrische Grubenlampe). Adolf Bohres. Illustrating a portable electric safety lamp with storage-battery cell and osmium incandescent lamp. 1200 w. Oesterr Zeitschr f Berg u Hüttenwesen—June 11, 1904. No. 63241 D.

Miners' Phthisis.

The Causes and Prevention of Miners' Phthisis. J. S. Haldane and R. Arthur Thomas. Abstract of a paper read before the Inst. of Min. and Met., with editorial. An investigation of the causes, concluding that the inhalation of stone dust is the principal cause, and suggesting a means of remedying this trouble. 5700 w. Eng News—June 16, 1904. No. 63408.

Mines.

Mines and Scenery. Arthur Lakes. Illustrated brief description of a typical Nevada mining region situated in the bottom of an ancient dried-up lake bed. 1400 w. Mines and Min—June, 1904. No. 63-148 C.

Mistakes.

Why Some Mines Are Abandoned and Why Others Should Be Resumed. Arthur Lakes. Discusses the reasons for some mistakes of miners and investors. 2000 w. Mines & Min—June, 1904. No. 63150 C.

Ore Deposits.

On the Formation of Certain Ore Deposits. F. Klockmann. Translated from the *Zeitschrift für praktische Geologie.* A discussion of ore deposits and their origin, the theories advanced, and current views. 2000 w. Eng & Min Jour—June 16, 1904. No. 63415.

Some of the Ore Deposits of Colorado. Arthur Lakes. Illustrates and describes deposits, mostly in highly volcanic regions. 1600 w. Min & Sci Pr—June 4, 1904. No. 63186.

Rock Drills.

Trials of the Siemens & Halske Crank Percussion Rock Drill (Ergebnisse mit Kurbel-Stoss-Bohr maschinen, System Siemens and Halske). R. Goebel. Data and results of tests with electric drills at Peine, Hannover. Details of working costs are given, the current being supplied from gas engines using furnace gases. 2000 w. Glückauf—June 4, 1904. No. 63249 B.

Sketching.

Free-Hand Sketching in the Mining Field. Arthur Lakes. On the importance of teaching sketching in technical education, naming some of the uses in the field, and offering some suggestions for education in mining sketching. 2200 w. Min Rept—June 9, 1904. Serial. 1st part. No. 63196.

Smelting.

Pyrite Smelting. A Review. Edward D. Peters. A review of a series of papers on this subject appearing in this journal since October 10, 1903, with the object of presenting in a concise form the results and opinions reached, to draw general deductions and to discuss points needing consideration. 2800 w. Eng & Min Jour —June 2, 1904. No. 63074.

Transvaal.

Machinery Improvements in Transvaal Mines. Explains the present conditions and shows how they have caused marked progress in minimizing the amount of manual labor. The use of rock drills and improved methods of handling the ore and waste products. 2700 w. Engng—June 17, 1904. No. 63499 A.

MISCELLANY.

Mica.

Mica Deposits. Fritz Cirkel. Notes the characteristic features of mica and the uses made of it; the various species and their commercial importance; the Canadian deposits and their value; other deposits, etc. Ills. 4800 w. Can Min Rev—May 31, 1904. Serial. 1st part. No. 63070 B.

The Production of Mica in the United States. Extracts from the report of J. A. Holmes for the year 1902. 900 w. Min Rept—May 26, 1904. No. 63020.

Petroleum.

Petroleum and Its Uses. Abstract of a paper by Dr. P. Dvorkovitz read before the Inst. of Min. Engrs. Considers the uses for illuminating, lubricating and fuel purposes. 1600 w. Mech Engr—June 18, 1904. No. 63548 A.

The Gas and Oil Fields of Kansas. The first of a series of articles on these oil and gas fields, describing present conditions. 1400 w. Min Wld—June 4, 1904. Serial. 1st part. No. 63193.

The Geology of the Boulder Oil Field. Arthur Lakes. A brief explanation of the structure of this region. 500 w. Min Rept—June 2, 1904. No. 63089.

Volcanic Origin of Oil. Eugene Coste. Discussion of the paper by Robert T. Hill, on "The Beaumont Oil Fields, with Notes on other Oil Fields of the Texas Region," claiming that it has been proved that the origin of oil is inorganic and the result of solfataric volcanic emanations. 3800 w. Jour Fr Inst—June, 1904. No. 63-342 D.

Radio-Activity.

Radio-Active Minerals. R. W. Brock. A record of results of tests of a number of minerals. 1500 w. Eng & Min Jour—June 2, 1904. No. 63076.

Tin.

Determination of Tin in Tailings and Slimes. George L. Mackenzie. Abstract of a paper before the Inst. of Min. and Met. Describes the scheme of assay employed by the writer. 1300 w. Eng & Min Jour—June 9, 1904. No. 63178.

On the Assay of Tin. J. H. Collins. Abstract of a paper read before the Inst. of Min. and Met. Briefly describes recent experiments showing that some varieties are soluble. 600 w. Eng & Min Jour—June 9, 1904. No. 63177.

Tin Scrap.

Tin Scrap Recovery Processes. John B. C. Kershaw. Gives details of all the processes which have attained industrial trial, with remarks upon operating cost and upon the future of the industry. Ills. 3000 w. Elec Rev, N. Y.—June 18, 1904. No. 63411.

Zinc.

Magnetic Concentration of Zinc Ore in Virginia. C. Q. Payne. Describes the ores and their treatment. Ills. 2000 w. Eng & Min Jour—June 23, 1904. No. 63512.

Zinc-Blende.

Luminescent Zinc-Blendes. A. S. Earle and W. J. Sharwood. Describes an extensive vein of ore recently found in California, giving analysis of the ore and showing the zinc-blende to be the luminescent constituent. 1500 w. Eng & Min Jour—June 23, 1904. No. 63511.

RAILWAY ENGINEERING

CONDUCTING TRANSPORTATION.

Car Service.

Per Diem, as Applied by Car Service Associations in Their Industrial Rule. W. M. Prall. Read at convention of the Nat. Assn. of Car Service Mgrs. An explanation of the object of these rules and their underlying principle. 1200 w. Ry Age—June 17, 1904. No. 63455.

Fast Run.

Some Features of the Great Western

Record Run. Charles Rous-Marten. Considers the coal consumption, steam pressure, &c. 2800 w. Engr, Lond—June 10, 1904. No. 63439 A.

The Record Run on the Great Western Railway. Charles Rous-Marten. Briefly describes the road over which the run was made and gives details of the work, explaining why it was undertaken. 4800 w. Engr, Lond—May 20, 1904. No. 63015 A.

Train Handling.

The Cause and Remedy for Freight Trains Breaking in Two. Two short papers by M. V. Quinn and C. P. Cass, discussing this subject. 4400 w. St. Louis Ry Club—May 14, 1904. No. 63310.

MOTIVE POWER AND EQUIPMENT.

Brakes.

An Important Application of the Storage Air-Brake System at Newark, N. J. Illustrated detailed description of the car equipment, compressor station, equipment, design of the system, &c. 2800 w. St Ry Jour—June 25, 1904. No. 63564 C.

Duplex Straight Air and Automatic Brake. J. P. Kelly. An explanation of the method of piping the New York Air Brake Co.'s Duplex Straight Air and Automatic Brake for switch engine and tender. 1500 w. Loc Engng—June, 1904. No. 63166 C.

Braking Power.

Basis of Unbraked Weight per Axle versus Ninety Per Cent. Plan for Passenger Equipment Cars. F. M. Nellis. Presented at the Buffalo Air Brake Convention. Discusses the inferiority of the 90 per cent. basis, and reports favorably on the uniform unbraked weight plan, as shown by an experimental train. 1600 w. Loc Engng—June, 1904. No. 63167 C.

Car Lighting.

See Electrical Engineering, Lighting.

Cars.

A New Dynamometer Car. Illustrated description of a car recently put in service by the International Correspondence Schools of Scranton, Pa. 1500 w. Ry & Engng Rev—June 18, 1904. No. 63452.

Experience in the Maintenance and Repair of Steel Freight Cars. Gives results of a recent inquiry as to current experience and practice in the maintenance and repair of these cars. 4800 w. Eng News—June 23, 1904. No. 63488.

Special Cars for Local Traffic at the St. Louis Exhibition; Wabash Railway. Brief illustrated description of side-door cars with steel underframes. 500 w. Eng News—June 9, 1904. No. 63179.

Steel Car Design. A. Stucki. Gives information based on several years' work in designing and building cars, supplemented with valuable data from the testing room. Gives analysis of stresses, arch-bars and axles in the present number. Diagrams. 1500 w. R R Gaz—June 17, 1904. Serial. 1st part. No. 63458.

The Giesecke Automatic Unloader for Railway Wagons. Illustrates a number of cars to which this device has been applied, describing the working. 1200 w. Col Guard—May 27, 1904. No. 63126 A.

The Problems of the Master Car Builder on the Electrified Steam Road. H. H. Vreeland. Also editorial. Shows that an extensive substitution of electricity for steam power would cause almost a complete revolution of repair-shop methods. 3000 w. St Ry Jour—June 25, 1904. No. 63567 C.

The Use of Steel in Passenger Car Construction. William Forsyth, Read before the M. C. B. Convention. Urges the use of steel in building stronger passenger cars, giving a design of car with steel underframe, and much of the body of steel. Ills. 2700 w. Ry & Engng Rev—June 25, 1904. No. 63577.

Coke Car.

Coke Car for the Cambria Steel Company. Plans and description of 50-ton steel hopper bin coke cars. 600 w. R R Gaz—June 17, 1904. No. 63457.

Fire-Box.

The Broton Locomotive Boiler with Water-Tube Fire-Box. Abstract of a paper by Johann Broton, published in the *Zeitschrift des österreichischen Ingenieur- und Architekten-Vereines*. Illustrated detailed description, with statement of advantages. 4500 w. Bul Int Ry Cong—May, 1904. No. 63121 E.

Heating Surface.

Heating Surface and Boiler Power. L. B. Jones. Compares the performance of a locomotive on the Pennsylvania R. R. with one on the Michigan Central, showing that a boiler with 2,640 sq. ft. of heating surface can maintain an output equal to the one with 3,505 sq. ft. 1700 w. R R Gaz—June 24, 1904. No. 63519.

The Value of Heating Surface. Lawford H. Fry. Discussing the relative value of the various parts of the heating surface in a locomotive. The present article gives a preliminary survey. 3800 w. R R Gaz—June 24, 1904. No. 63517.

Leaks.

To Locate Blows on Tandem Compound Engines. S. H. Draper. Suggestions for locating the blowing of steam by sound. 700 w. Loc Engng—June, 1904. No. 63168 C.

Locomotives.

Automatic Control of Locomotives. Illustrated description of apparatus controlling the throttle of a locomotive, and the system of automatic signalling. 800 w. Sci Am—June 18, 1904. No. 63384.

Baldwin Four-Cylinder Balance Compound for the Burlington. Illustrated general description. 600 w. R R Gaz—June 3, 1904. No. 63105.

Big Locomotive Overloading and Locomotive Failures. Gives five questions sent to leading railroad officials, with the replies received. 8000 w. Am Engr & R R Jour—June, 1904. No. 63156 C.

Compound Locomotives. Charles S. Lake. A discussion of the subject of compounding, and the practice in Great Britain. Concludes that the compound locomotive is far from a perfect machine, but capable of development to much greater excellence. 3000 w. Prac Engr—May 27, 1904. No. 63042 A.

Eight-Coupled Locomotive for the Queensland Government Railways. Two-page plate, illustration, and description. 800 w. Engng—May 27, 1904. No. 63-128 A.

Eight-Wheel Passenger Locomotive for the London & North-Western. Illustrated description of a new fast passenger engine. 400 w. R R Gaz—June 24, 1904. No. 63520.

Four-Cylinder Balanced Compound for the Prussian State Railways. Illustrated detailed description of a locomotive on exhibition at St. Louis, a type used on the Prussian State Railways. 600 w. R R Gaz—June 24, 1904. No. 63516.

Four-Cylinder Balanced Compound Locomotive, New York Central Ry. Illustrates and describes an Atlantic (4-4-2) engine designed by F. J. Cole. 1200 w. Eng News—June 23, 1904. No. 63485.

Four-Cylinder Compound Locomotive, Paris-Orleans Railway. Illustrations, description and principal dimensions. 600 w. Engr, Lond—June 3, 1904. No. 63373 A.

Four-Cylinder De Glehn Compound Locomotive. Inset, with detailed description and general dimensions of the 4-4-2 type of the Paris-Orleans Railway of France. The illustrations indicate the construction, with the exception of a few details, of the new Pennsylvania locomotive of this type. 1500 w. Am Engr & R R Jour—June, 1904. No. 63155 C.

Four-Cylinder Locomotives at the St. Louis Exhibition. Brief descriptions of the types shown. 3300 w. Engr, Lond—May 27, 1904. No. 63132 A.

Locomotives at the St. Louis Exhibition. H. W. Hanbury. Briefly notes the important features of the transportation exhibits and begins a survey of the exhibits of the United States. 3800 w. Engng—May 27, 1904. Serial. 1st part. No. 63129 A.

Locomotive for the Great Central Railway. Principal dimensions and illustrations of a powerful engine of the Atlantic type. 700 w. Engr, Lond—June 10, 1904. No. 63443 A.

Mallet Articulated Compound Locomotive, B. & O. R. R. Illustrated detailed description of the heaviest locomotive ever built. 700 w. Ry & Engng Rev—May 28, 1904. No. 63035.

New Consolidation Locomotives for the Oregon Short Line. Illustrated description of recently built heavy locomotives. 500 w. Ry Age—June 24, 1904. No. 63,-571.

Rebuilding Locomotives—Philadelphia & Reading. S. F. Prince, Jr. An illustrated article giving examples of rebuilding. 500 w. R R Gaz—June 24, 1904. No. 63518.

Some Old High-Speed Engines. Herbert T. Walker. An illustrated article on some English express engines of historical interest. 3300 w. R R Gaz—June 17, 1904. No. 63461.

Vauclain Four-Cylinder Balanced Compound. Illustrated description of a 4-4-2 type for passenger service on the Chicago, Burlington & Quincy railway. 500 w. Am Engr & R R Jour—June, 1904. No. 63,-157 C.

Locomotive Testing.

See Mechanical Engineering, Measurement.

Machine Tools.

Railroad Shop Tools. An illustrated description of the present state of the art, and the changes made necessary by the use of high-speed tool steel. 1000 w. R R Gaz—June 17, 1904. Serial. 1st part. No. 63460.

Motor Coaches.

Railroad Motor Coaches Near London. W. B. Paley. Describes the cars introduced on the Great Western railway. 1400 w. R R Gaz—June 10, 1904. No. 63185.

Oscillations.

Model to Illustrate the Oscillations of a Locomotive. H. von Borries. Abstract of a paper read before the Verein für Eisenbahnkunde. Illustrates and describes this model. 1700 w. Bul Int Ry Cong—May, 1904. No. 63122 E.

Train Resistance.

Train Resistances and Locomotive Efficiencies (Die Bewegungswiderstände der Eisenbahn fahrzenge und die Leistungsfähigkeit der Lokomotiven). H. von Borries. A discussion of the performance of steam locomotives in the light of the high-speed electric trials. 2500 w. Zeitschr d ver Deutscher Ing—May 28, 1904. No. 63217 D.

Underframes.

The Design of a Steel Underframe of Standard Shapes for Freight Cars. Fritz B. Ernst. Gives design made up of standard shapes, with the exception of the bolsters, showing the method by which the different parts may be calculated. 5500 w. Ry Age—June 17, 1904. No. 63454.

Water Purification.

See Mechanical Engineering. Steam Engineering.

Wheels.

Specifications for Car Wheels. C. B. Dudley. Specifications prepared for the American Society for Testing Materials, containing important improvements which are explained by the writer. 2800 w. Am Engr & R R Jour—June, 1904. No. 63159 C.

NEW PROJECTS.

Africa.

The Swakopmund-Windhuk Narrow Gauge Railway in German Southwest Africa (Trassierung, Bau und Leistungsfähigkeit der Schmalspurigen Eisenbaln Swapokmund-Windhuk in Deutsch-Südwest Afrika) Major Pophal. An account of the location, construction and operation of 307 kilometres of railway in the country of the Hereros. 7000 w. Glasers Annalen—June 1, 1904. No. 63235 D.

Borneo.

The British North Borneo Railway. An Illustrated account of conditions and the power of the railway, the rules enforced, &c. 1200 w. Loc Engng—June, 1904. No. 63165 C.

New Lines.

The Great Western and Great Central New Railways. Describes new lines in England, giving a description of the construction, the difficulties and information of interest. Ills. 3000 w. Engr, Lond—May 27, 1904. No. 63134 A.

Oklahoma.

The Eastern Oklahoma Railway Line and Bridges. F. R. Patten. An illustrated description of the line and its construction. 3500 w. Ry Age—June 17, 1904. No. 63456.

Peru.

See Industrial Economy.

South America.

South American Railway Building. Charles M. Pepper. Information concerning lines under construction and projected in the different countries. 2500 w. Ry Age—June 3, 1904. No. 63090.

PERMANENT WAY AND BUILDINGS.

Coal Handling.

Coal Shipping Plant at Hoboken, D., L. & W. R. R. Illustrates and describes an installation on the McMyler system, adapted to the tidewater conditions of a coal-handling road. 1000 w. Ry & Engng Rev—May 28, 1904. No. 63037.

Crossings.

Some Modern Appliances Connected with Railway Crossings and Points O. R. Williams. Read befoe the Inst. of Engrs. & Shipbuilders in Scotland. Considers these appliances, stating the reasons why they are wanted, the qualities they ought to possess, &c. 2500 w. Prac Engr—June 10, 1904. Serial. 1st part. No. 63430 A.

Location.

Location of the Clinch Valley Division, N. & W. Emile Low. Deals especially with the location between St. Paul and Coeburn, Va., where some unusual problems were solved. Ills. 2500 w. R R Gaz—June 10, 1904. No. 63184.

Pier Shed.

A Steel Pier Shed for the Central Railroad of New Jersey. Brief illustrated description. 400 w. Ry Age—June 24, 1904. No. 63572.

Rails.

Some Notes on the Creeping of Rails. Samuel Tobias Wagner. A report of a series of observations made for the Philadelphia and Reading Railway Company upon the creeping rails at a number of points on their lines. 4000 w. Pro Am Soc of Civ Engrs—May, 1904. No. 62,997 E.

Roundhouse.

New Roundhouse, C. M. & St. P. Ry. at Galewood, Ill. Plan and description. 1600 w Ry & Engng Rev—June 25, 1904. No. 63575.

Shops.

Danville Shops of the Chicago & Eastern Illinois Railway. Illustrated detailed description of the new shops at Oaklawn, east of Danville, and their equipment. 3500 w. Ry Mas Mech—June, 1904. No. 63161.

Improvements at the Oelwein Shops, Chicago Great Western Ry. Illustrates and explains the changes made in the original equipment of these shops. 6500 w. Ry & Engng Rev—June 25, 1904. No. 63576.

Repair Shops for Small Roads. Francis G. Daniell. Suggestions for design, equipment, &c. 1500 w. St Ry Jour—June 18, 1904. No. 63449 C.

Signaling.

Signals on the Interborough Rapid Transit Lines in New York City. An illustrated detailed description of the scheme adopted, which is a departure from any previous installation. 3300 w. Ry Age—June 17, 1904. No. 63453.

Storehouse.

The Storehouse System at Altoona. George L. Fowler. An explanation of the method of receiving, storing, distributing and transferring material, giving forms used. 3000 w. Eng News—June 2, 1904. No. 63459.

Terminal.

Excavation and Retaining Wall for the Pennsylvania R. R. Terminal Station, New York City. Brief illustrated description of the contract plans for the underground terminal and its construction. 3000 w. Eng News—June 2, 1904. No. 63081.

Tie Timber.

Proposed Improvements in Ties and Rail Fastenings. Abstract of Bulletin No. 50, published by the Bureau of Forestry, dealing with economical features of the production and use of ties and of forms of rail fastenings, prepared by Hermann von Schrenk. Ills. Also editorial. 9000 w. Ry & Engng Rev—June 11, 1904. No. 63305.

Timber.

Some Problems in the Use of Timber by Railroads. Hermann von Schrenk. Discusses the tie problem of supply, and timber preservation. 2000 w. Jour Worcester Poly Inst—May, 1904. No. 63318 C.

Treenails.

The Use of Screwed Wood Bushes (Treenails) in Wooden Sleepers for Increasing the Resistance of Spikes. Mr. Schwabach, in *Glasers Annalen für Gewerbe und Bauwesen.* Describes methods employed by the "Dubelwerke" Company, for fixing rails more securely. Ills. 1500 w. Bul Int Ry Cong—May, 1904. No. 63123 E.

Tunnel Ventilation.

The Ventilation of the Albespeyré Tunnel, France. Dr. Alfred Gradenwitz. An account of the large size machinery required and the difficulties met with. Ills. 1400 w. Eng Rec—June 4, 1904. No. 63102.

Tunnels.

See Civil Engineering, Construction.

STREET AND ELECTRIC RAILWAYS

Batteries.

On the Calculation of Line Batteries. W. E. Winship. Discusses the calculation of storage-batteries used in railway work for the purpose of maintaining the line pressure at points distant from the generating stations, comparing the results with those obtained by the use of copper. 2200 w. Trans Am Inst of Elec Engrs—April, 1904. No. 63160 D.

Berlin.

Recent Elevated Practice in Berlin. John P. Fox. An illustrated article describing how noise was largely prevented, the road made attractive, &c. 2800 w. St Ry Jour—June 4, 1904. No. 63152 C.

California.

Notes on the San Diego and Coronado Railway Systems. Illustrates and describes the equipment, the double-deck cars, and interesting features in general. 3500 w. St Ry Jour—June 4, 1904. No. 63153 C.

Canton, Ohio.

Some Details of an Electric Railway Power Station at Canton, Ohio. Gives illustrated description of interesting details from the standpoint of design, in the station serving the Canton-Akron railway. 1800 w. Eng Rec—June 25, 1904. No. 63559.

Derby.

Derby Electricity Works and Tramways. An illustrated description of extensions, and changes being made at Derby. 2500 w. Elect'n, Lond—June 10, 1904. Serial. 1st part. No. 63434 A.

Electric Locomotives.

Control System, Motors and Shoes of the Baltimore & Ohio Locomotives. Particulars and illustrations of these electric locomotives. 1100 w. St Ry Jour—June 25, 1904. No. 63563 C.

Electric Locomotives for the New York Central & Hudson River R. R. Illustrations and descriptions of these machines which differ radically in their electrical features from any hitherto constructed. 1500 w. Eng News—June 2, 1904. No. 63080.

Exposition.

Electric Transportation Within the World's Fair Grounds. Cloyd Marshall. Information concerning the intramural electric railway, electric automobiles, launches, &c. 1500 w. Elec Wld & Engr—June 4, 1904. No. 63110.

Feeders.

The Distribution of Electrical Energy for Large Railway Systems. (Ueber die Zuführung Elektrischer Energie für Grössere Bahnnetze) W. Reichel. Discussing especially the feeder arrangements of the high-speed, military railway, Marienfelde-Zossen. 6000 w. Elektrotech. Zeitschr—June 9, 1903. No. 63211 B.

Fire Car.

Elevated Car for Fire Fighting. Illustrated description of a novel car equipment for fire protection used on the elevated railway of Chicago. It consists essentially of an outfit of chemical extinguishers of large capacity housed in a fireproof car body. 1500 w. St Ry Jour—June 11, 1904. No. 63301 C.

High Speed.

High-speed Electric Railway Experiments on the Marienfelde-Zossen Line. Alexander Siemens. Read before the Inst. of Elec. Engrs. A short history of the trials made on this military railway and of the preparation for them and results. 4800 w. Elect'n, Lond—June 10, 1904. Serial. 1st part. No. 63435 A.

High Tension.

High Tension Transmission for Electric Railways. W. J. Davis, Jr. Read befor the New England St. Ry. Club. Considers present practice, discussing regulation, connections, construction, and insulators. 2000 w. St Ry Jour—June 25, 1904. No. 63566 C.

Interurban.

Interurban Electric Railway Practice in Indiana. Information from a paper by Robert P. Woods, read before the Indiana Engineering Society. Ills. 4500 w. St Ry Jour—June 18, 1904. No. 63450 C.

The Canton and Akron Railway. Outlines the history of this line which is a part of the system controlled by Tucker, Anthony & Company, giving illustrated description and account of the management and operation. 7800 w. St Ry Jour —May 28, 1904. No. 63028 C.

Italy.

Railway Politics and Electric Railways in Italy (Eisenbahnpolitik und Elektrischer Bahnbetrieb in Italien) Pietro Lanino. A review of the relations between steam and electric railways in Italv. 2000 w. Elektrotech Zeitschr—May, 26, 1904. No. 63202 B.

Leicester.

Leicester Corporation Electric Tramways. Illustrated detailed description of a trolley system constructed on the latest designs. 10800 w. Tram & Ry Wld—May 12, 1904. No. 63002 B.

Main Line.

The Liverpool and Southport Railway (Chemin de Fer de Liverpool à Southport) M. Debeul. General description of the third-rail equipment of the branch of the Lancashire and Yorkshire railway, between Liverpool and Southport. 2000 w. Génie Civil—May 28, 1904. No. 63228 D.

New Orleans.

The Power Plants of the New Orleans Railways Company. An illustrated detailed description of the plants, and information of related interest. 4000 w. St Ry Jour—June 18, 1904. No. 63448 C.

Operation.

The Operation of Street Railways in the Interests of the Residents (Rücksichtuahme bei Herstellung von Strassenbahnen auf die Interessen der Anlieger) W. Mende. An examination of the German law in connection with street railway operation. 4000 w. Zeitschr d Ver Deutscher Ing—June 11, 1904. No. 63223 D.

Polyphase.

Single versus Polyphase Generators in Alternating-Current Railway Work. W. A. Blanck. A consideration as to the selection of the generators delivering the energy to the system. 1300 w. Elect'n, Lond—May 27, 1904. No. 63120 A.

Safety Appliances.

Report of the Commission on Safety Appliances for Electric Railways. (Vorschlag der Sicherheits Kommission betreffend Sicherheitsvorschriften für Elektrische Bahnanlagen). The preliminary report submitted to the Electrotechnical Society for discussion. 3000 w. Elektrotech Zeitschr—June 2, 1904. No. 63,-208 B.

Scarborough.

Scarborough Electric Tramways. Illustrated detailed description of the lines to this seaside resort in England. The exceptional feature is the passage of the line right over the roof of the Aquarium. 1400 w. Tram & Ry Wld—May 12, 1904. No. 63003 B.

Terminal.

An Improved Terminal for Handling the Heavy Coney Island Crowds—Brooklyn Rapid Transit Company. Illustrates and describes the new terminal plan for handling the enormous traffic at this resort. 2000 w. St Ry Jour—June 11, 1904. No. 63300 C.

Tramways.

Overhead Tramway Construction. Deals with the design, selection, arrangement and erection of overhead line material, discussing standard practices, and pointing out the leading features of the best design. 3300 w. Elec Rev, Lond—May 27, 1904. No. 63117 A.

Walsall.

Municipal Tramways at Walsall. An illustrated account of this electric tramway undertaking 3000 w. Tram & Ry Wld—June 9, 1904. No. 63483 B.

EXPLANATORY NOTE—THE ENGINEERING INDEX.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language,* together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. Certain journals, however, make large extra charges for back numbers. In such cases we may have to increase proportionately the normal charge given in the Index. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* Boston.
American Electrician. *m.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Jl. of Science. *m.* New Haven, U.S.A.
American Machinist. *w.* New York.
American Shipbuilder. *w.* New York.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. d Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *qr.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Sydney.
Autocar. *w.* Coventry, England.
Automobile. *m.* New York.
Automobile Magazine. *m.* New York.
Automotor Journal. *w.* London.
Beton und Eisen. *qr.* Vienna.
Brick Builder. *m.* Boston.
British Architect. *w.* London.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bulletin American Iron and Steel Asso. *w.* Philadelphia, U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. Soc. Int. d Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bulletin Univ. of Kansas. *b-m.* Lawrence.
Bull. Int. Railway Congress. *m.* Brussels.
California Jour. of Tech. *m.* Berkeley, Cal.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Montreal.
Canadian Mining Review. *m.* Ottawa.
Cassier's Magazine. *m.* New York.
Central Station. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *m.* Chicago.

Electrical Engineer. *w.* London.
Electrical Review. *m.* London.
Electrical Review. *w.* New York.
Electrical World and Engineer. *w.* New York.
Electric Club Journal. *m.* Pittsburg, Pa.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *w.* New York.
Electrochemical Industry. *m.* New York.
Electrochemist and Metallurgist. *w.* London.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Chicago.
Engineering. *w.* London.
Engineering and Mining Journal. *w.* New York.
Engineering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Engineering Review. *m.* London.
Eng. Soc. of Western Penna. *m.* Pittsburg, U.S.A.
Engineering Times. *m.* London.
Fire and Water. *w.* New York.
Foundry. *m.* Cleveland, U. S. A.
Gas Engineers' Mag. *m.* Birmingham.
Gas World. *w.* London.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e. d. Str. Ferr. *w.* Rome.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Ice and Refrigeration. *m.* New York.
Ill. Zeitschr. f. Klein u. Strassenbahnen. *s-m.* Berlin.
Ingenieria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron and Steel Metallurgist. *m.* Boston.
Iron and Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. Am. Foundrymen's Assoc. *m.* New York.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Journal of Sanitary Institute. *qr.* London.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery *b-m.* Fort Monroe, U.S.A
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, U.S.A.
Locomotive. *m.* Hartford, U. S. A
Locomotive Engineering. *m.* New York.
Machinery. *m.* New York.
Madrid Cientifico. *t-m.* Madrid.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U. S. A.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Metal Worker. *w.* New York.
Métallurgie. *w.* Paris.
Minero Mexicano. *w.* City of Mexico.
Minerva. *w.* Rome.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci Press. *w.* San Francisco.
Mining Reporter. *w.* Denver, U. S. A
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
Modern Machinery. *m.* Chicago.
Mouvement Maritime. *w.* Brussels.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *m.* New York.
Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Nineteenth Century. *m.* London.
North American Review. *m.* New York.
Oest. Wochenschr. f. d. Oeff. Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg- & Hüttenwesen. *w.* Vienna.
Ores and Metals. *w.* Denver, U. S. A.
Pacific Coast Miner. *w.* San Francisco.
Page's Magazine. *m.* London.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Proceedings Engineers' Club. *qr.* Philadelphia.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Progressive Age. *s-m.* New York.
Quarry. *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago.
Review of Reviews. *m.* London & New York.
Revista d Obras. Pub. *w.* Madrid.
Revista Tech. Ind. *m.* Barcelona.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Gen. des Sciences. *w.* Paris.
Revue Industrielle. *w.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Gen. d Ferrovie. *w.* Florence.
Rivista Marittima. *m.* Rome.
Schiffbau. *s-m.* Berlin.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Engng. *m.* Ithaca, N. Y.
Stahl und Eisen. *s-m.* Düsseldorf.
Stevens' Institute Indicator. *qr.* Hoboken, U.S.A.
Stone. *m.* New York.
Street Railway Journal. *m.* New York.
Street Railway Review. *m.* Chicago.
Tijds. v h Kljk. Inst. v Ing. *qr.* Hague.
Traction and Transmission. *m.* London.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Transport. *w.* London.
Wiener Bauindustrie Zeitung. *w.* Vienna.
World's Work. *m.* New York.
Yacht. *w.* Paris.
Zeitschr. d. Mitteleurop. Motorwagen Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochcemie. *w.* Halle a S.
Zeitschr. f. Elektrotechnik. *w.* Vienna.

CURRENT RECORD OF NEW BOOKS

NOTE—*Our readers may order through us any book here mentioned, remitting the publisher's price as given in each notice. Checks, Drafts, and Post Office Orders, home and foreign, should be made payable to* THE ENGINEERING MAGAZINE.

Discount Book.

The Thomas Discount Book. Edited and compiled by Millward T. Thomas. Size, 8 by 5 in.; pp. 81. Price, cloth, $1; leather, $1.25. Williamsport, Pa.: Millward T. Thomas.

In many lines of business it is customary to allow discounts from the list prices of goods, and where there are combinations of several discounts, the figuring of the net price is a tedious operation, and may often give rise to errors. In order to avoid these troubles, and to smooth the way for the busy accountant and merchant, the tables in this book have been compiled. They include discounts from 2½ to 90 per cent., both simple and combined, and are arranged in convenient form, so that by entering a table with the list price, the net price is at once found. But this is not the only function which these tables can perform, for they can be applied to finding discounts for specified list and net prices, to making list prices when the discount and the net price are known, to adding any per cent. of profit upon the cost, to comparing prices, and to other uses. The book has a marginal index, is of a handy size and is well bound in flexible cloth or leather.

Iron and Coal.

National Iron and Steel, Coal and Coke Blue Book. Second Edition. Edited by B. H. Morwood. Size, 9 by 6 in.; pp. 890. Price, $7.50. Pittsburg: R. L. Polk & Co.

The magnitude of the iron and coal business in the United States makes it very important, if not absolutely necessary, to have a work of reference which shall give authentic information about the various individuals and corporations engaged in these great industries. Such information, arranged in convenient form, is contained in the present "blue book," which, to begin with, has an alphabetical index of iron and steel products, with references to the manufacturers of the respective articles. Next comes the names of iron and steel companies, grouped according to the general character of the works, and then follows a list of practically all the corporations and firms in the United States, Canada and Mexico, which operate plants for the production of iron and steel, giving date of incorporation, capital stock, board of directors, names of partners and principal officers, description of works, including the railroads they are situated on, capacity of plants, and other data concerning each company, with cross references showing by whom the different works are controlled or owned. There follows an alphabetical list of directors, officers, managers, superintendents and other officials, with the names of their respective companies, and then comes a list of blast furnaces and iron and steel works, grouped by States and towns. The latter part of the book contains the data relating to coal and coke. There are alphabetical lists of the coal operators and coke manufacturers of the United States, and there is a list arranged by States and districts of all the producing coal mines, with the method of mining, tonnage and other information about each mine. From the mere statement of its contents, it can readily be seen how valuable this "blue book" must prove to everyone interested in iron, steel, coal, coke and their products.

BOOKS RECEIVED.

Cross-Tie Forms and Rail Fastenings, with Special Reference to Treated Timbers. (Bulletin No. 50 of U. S. Bureau of Forestry.) By Hermann von Schrenk. Washington: U. S. Department of Agriculture.

L'Industrie Aurifère au Transvaal; Son Passé—Son Avenir. By Albert Michaut. Price $2.00. Paris: A. Lahure, 9 Rue de Fleurus.

Moody's Manual of Corporation Securities. 1904 Edition. John Moody, Editor; C. L. F. Bridge and Louis W. Holschuh, Associate Editors. Price, cloth, $10; flexible leather, $12. New York and Chicago: Moody Publishing Co. London: Effingham Wilson.

Oil Engines. Second Edition. By A. H. Goldingham, M. E. Price, $2. New York: Spon & Chamberlain. London: E. & F. N. Spon, Ltd.

General Index to the Street Railway Journal, by Subjects and Authors, from Oct., 1884, to Dec., 1903. Price, $5. New York: McGraw Publishing Company.

Report of Proceedings of the International Fire Prevention Congress, London, 1903. By Ira H. Woolson, E. M., Official Representative for the City of New York. New York: Office of the President of the Borough of Manhattan.

THE ENGINEERING MAGAZINE
"THE WORLD IS ITS FIELD"

VOL. XXVII. SEPTEMBER, 1904. NO. 6.

THE NEW YORK RAPID-TRANSIT SUBWAY.

By H. C. Fyfe.

The New York rapid-transit subway, which is just on the eve of being opened to the public, is notable not only as the largest system of the kind ever undertaken, but further as the one which has been most opposed by difficulties of construction. Local geology and existing conditions in the streets, above ground and below, beset the work with delays and obstacles. The details of the auxiliary and collateral works, needed to clear the ground for the main undertaking, bristled with vexatious problems. The solution has been reached through the liberal outlay of money by the city, and the courage, ingenuity, and skill of those in actual charge of the construction.

The following pages, in text and engravings, give a clear and comprehensive review of the entire work. Mr. Fyfe died in March last, before the article had been put into type. We are indebted to the office of William Barclay Parsons, Esq., chief engineer to the Rapid Transit Commissioners, for the official maps and many of the photographs, and especially to George S. Rice, Esq., deputy chief engineer of the Rapid Transit Commission, and John Van Vleck, Esq., mechanical engineer of the Interborough Company, for revising Mr. Fyfe's proofs and bringing the account up to date in complete accuracy.—THE EDITORS.

THE New York Rapid Transit Subway, a portion of which will be opened for travel this month, has a very special interest in that it is the only sub-surface railway which has four tracks, two for local and two for express trains. It is also noteworthy in that portions are in a shallow subway and portions on an elevated structure, and in this it resembles the new Berlin Combined Elevated and Underground Railway, which was described in these pages last month.

In the case of London, the fact that the substratum of the Thames valley under the metropolis is composed of "London clay," with no rock or gravel, renders the work of tube construction both easy and rapid. The water lying in the gravel above the clay cannot permeate

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through the latter. But New York is built mainly upon rock, with some deep pockets of sand, and therefore the task of making a railway below the surface is one of great expense and difficulty.

The land on which New York is built was bought by Peter Minuit in 1626 for $24. In 1653 it had a population of 1,120; in 1731 of 8,256; in 1800 of 60,489; in 1850 of 515,547, while in 1900 Greater New York had a population of 3,437,202.

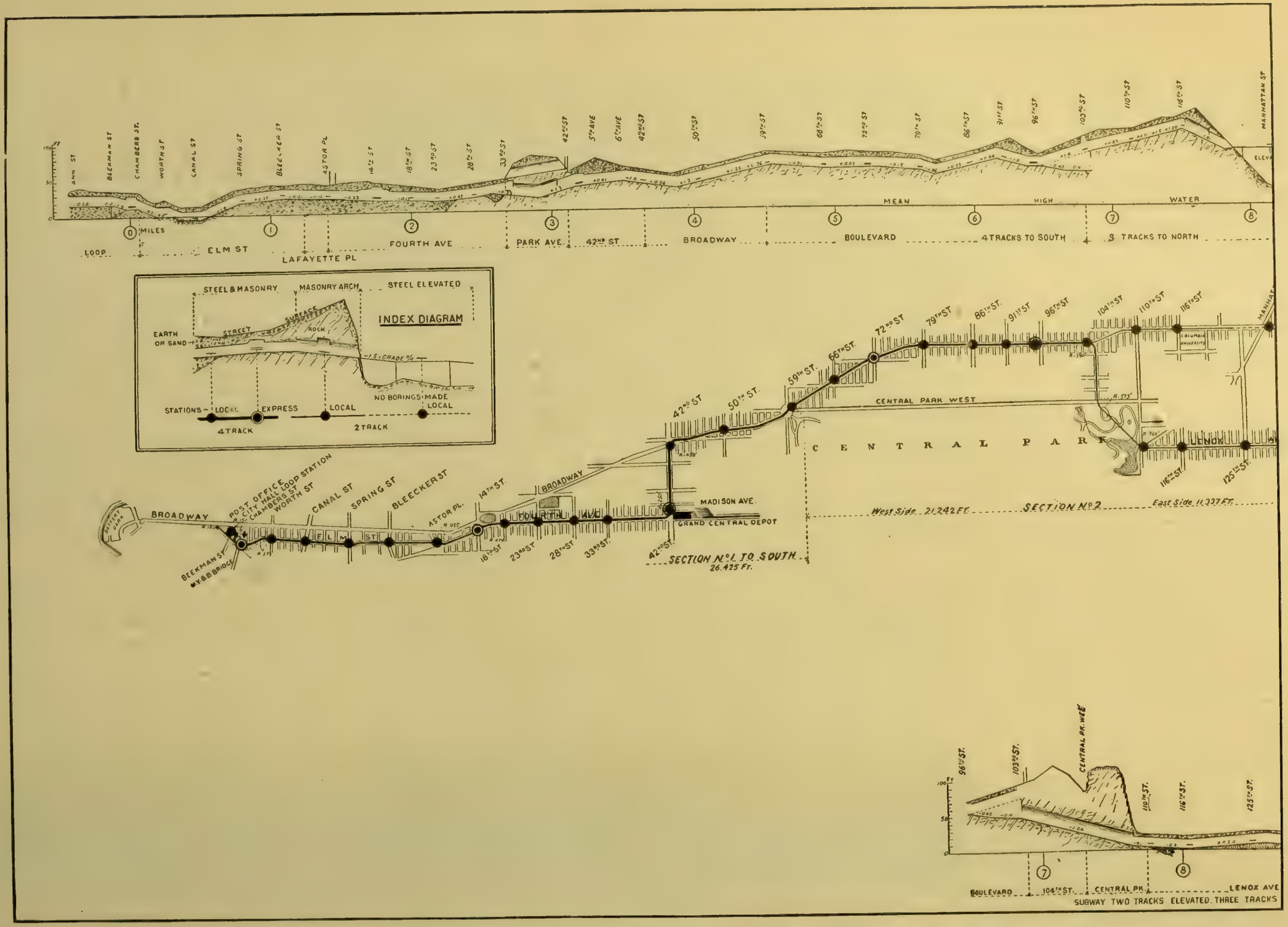
As far back as the middle of the last century, the pressure of necessity for rapid-transit facilities which could keep pace with this fast-growing population began to make itself felt. For a time the street railways were the only answer offered to the problem. The elevated railways, built against much opposition under the Rapid Transit Act of 1875, promised for a time to cope with the conditions; but their insufficiency soon became apparent, and in spite of every effort to increase their carrying capacity—even the recent change from steam to electric power—they have steadily fallen further and further behind the demands put upon them. What the rate of increase of these demands has been is best indicated by the figures of the north-and-south travel—the principal component of the total city traffic, and the only one directly affected by the additional facilities afforded by the subway we are reviewing. These figures were, for 1892, 391,000,000; for 1896, 440,000,000; for 1899, 553,000,000, and for 1902, 627,000,000. Rapid-transit legislation was passed, and commissions were appointed in 1890 and 1891; but no definite project was actually advanced to the stage of construction until the present commission, appointed in 1894, had been in office for some years. The general outlines of the scheme were settled in 1897, and the plans submitted to bidders and the contracts let in 1900.

Before deciding upon the main outlines of the project, the commission went thoroughly into the question of shallow subways and deep tunnels, finally deciding on the former type of construction. Each, of course, has its own peculiar advantages and disadvantages; but it must be remembered that on account of its peculiar shape, New York can spread only in one direction, and therefore on its main lines of communication there is a congestion of traffic far exceeding that to be found in any other city of the world. This being so, it is evident that no system of elevators could be installed at reasonable expense to cope with the enormous number of passengers at certain stations along the route. The commission reported that for a rapid-transit system to fulfil the first object of its existence, it must be close to the surface and be accessible without the use of elevators.

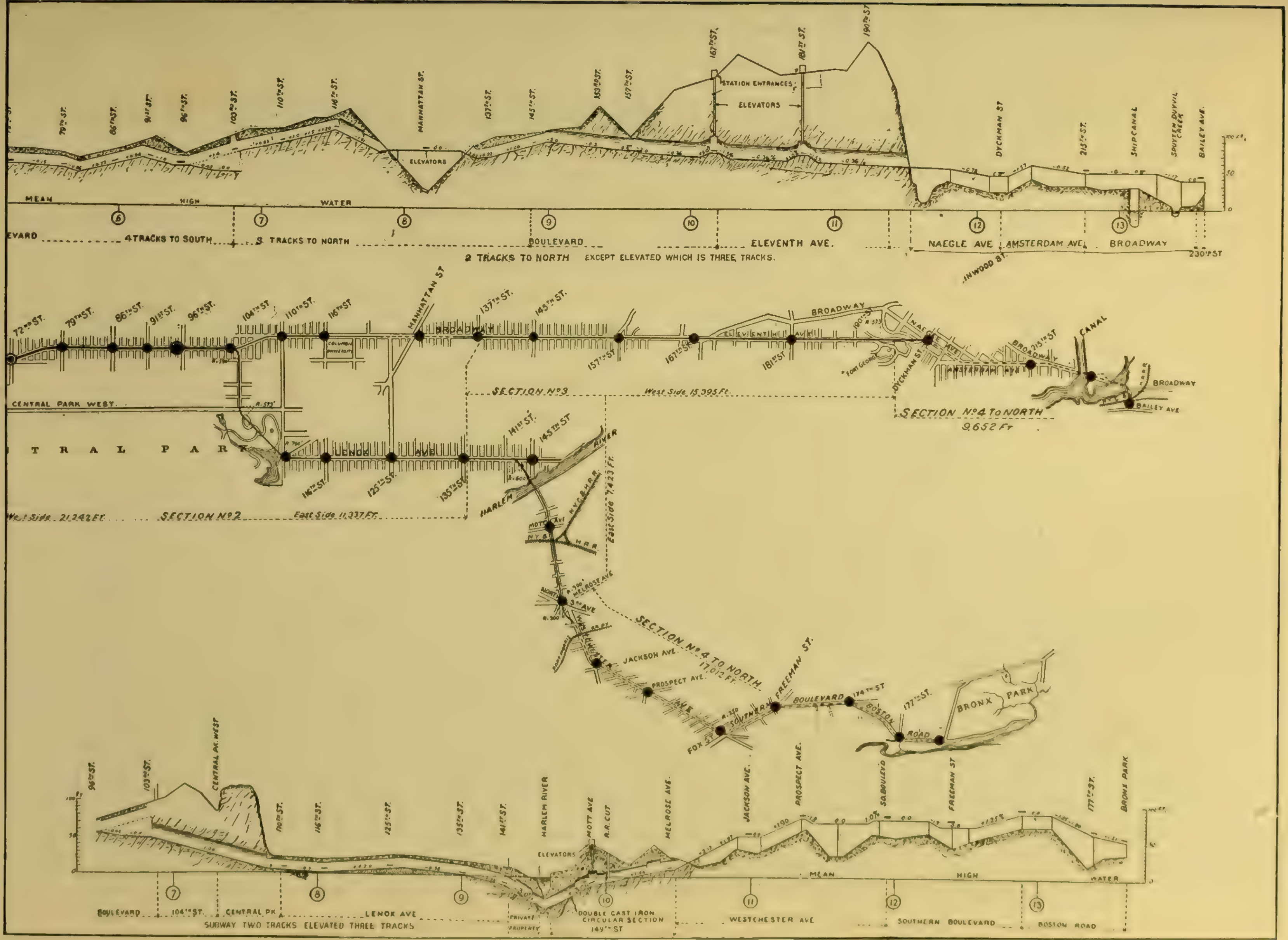
The vote of the people sanctioning the plan of municipal ownership having been obtained, the commission proceeded to the question of the route, and after much litigation the following was the one originally decided upon. It was to begin with a loop at the Post Office; thence with four tracks it goes direct to the Grand Central Station, in Forty-second street, thence westerly to Broadway and along that thoroughfare to One Hundred and Fourth street, a distance of seven miles; here the four tracks divide; one double-track and three-track line continues along Broadway to Kingsbridge, while another double-track line crosses under the Harlem River and proceeds to Bronx Park and the Zoological Gardens over a three-track viaduct; each of these branches is 7 miles long, or a total length for the whole system of 21 miles. The northerly ends of the three-track lines are to be elevated structures for a combined distance of 7.14 miles, and there will also be a short length of high steel viaduct ½ mile long crossing Manhattan Valley, an abrupt depression on the west side. All the remainder will be underground.

THE CITY HALL LOOP—DOWNTOWN STARTING POINT OF THE FIRST SUBWAY CONTRACT.

For the first 7 miles there will be four tracks; on the center pair trains will be run at all hours of the day in both directions, stopping at stations about 1½ miles apart and making a speed of at least 30

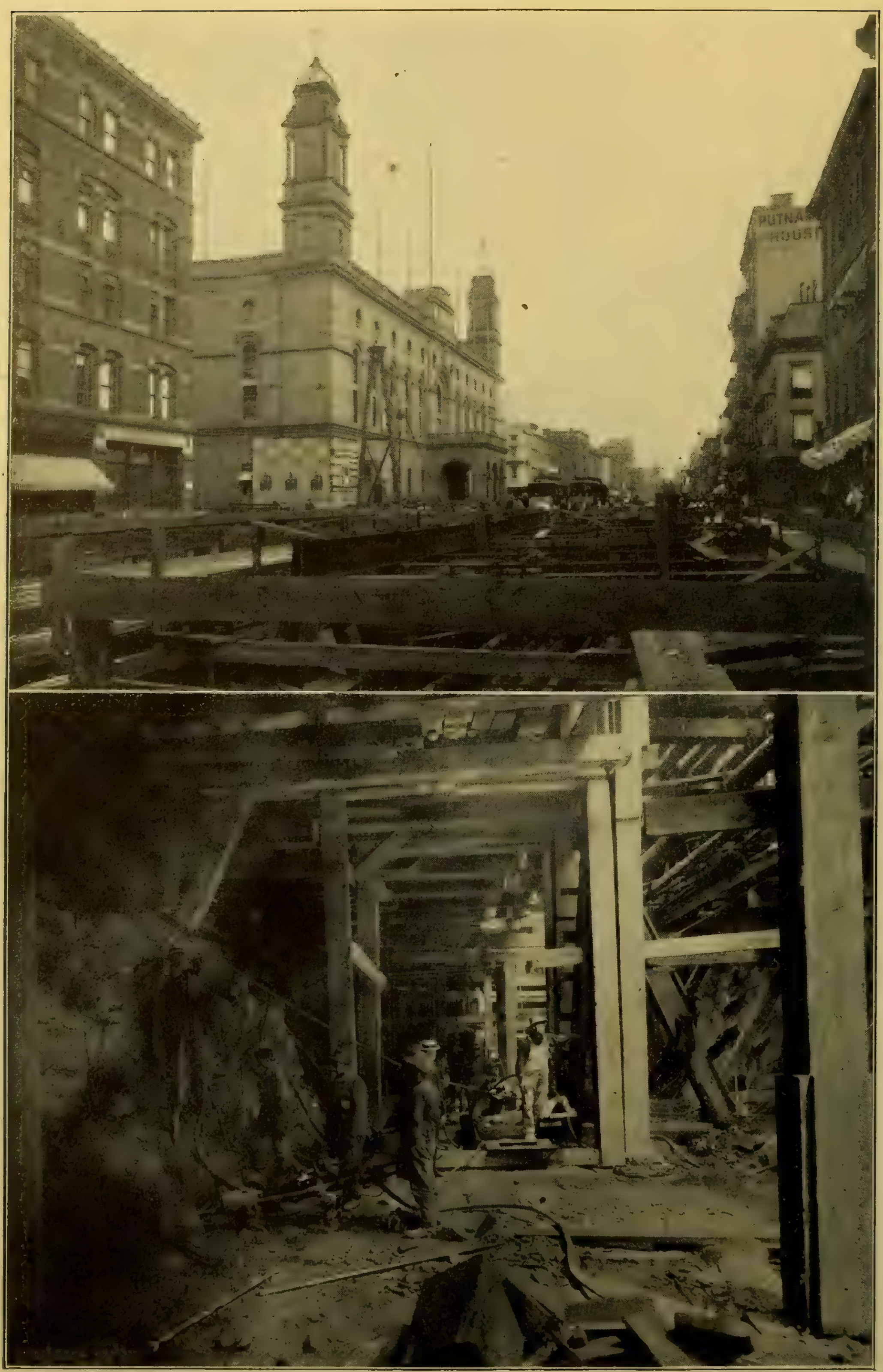


OFFICIAL MAP OF THE NEW YORK SUBWAY, SHOWING THE SOUTHERN PART OF THE ROUTE.



OFFICIAL MAP OF THE NEW YORK SUBWAY, SHOWING THE NORTHERN PART OF THE ROUTE.

The map partially overlaps that on page 884.



CUT-AND-COVER WORK IN A BUSY STREET—ABOVE AND BELOW GROUND.

The upper view shows the surface of Fourth Avenue, at Madison Square Garden. The lower is taken underground, at almost the same spot and date.

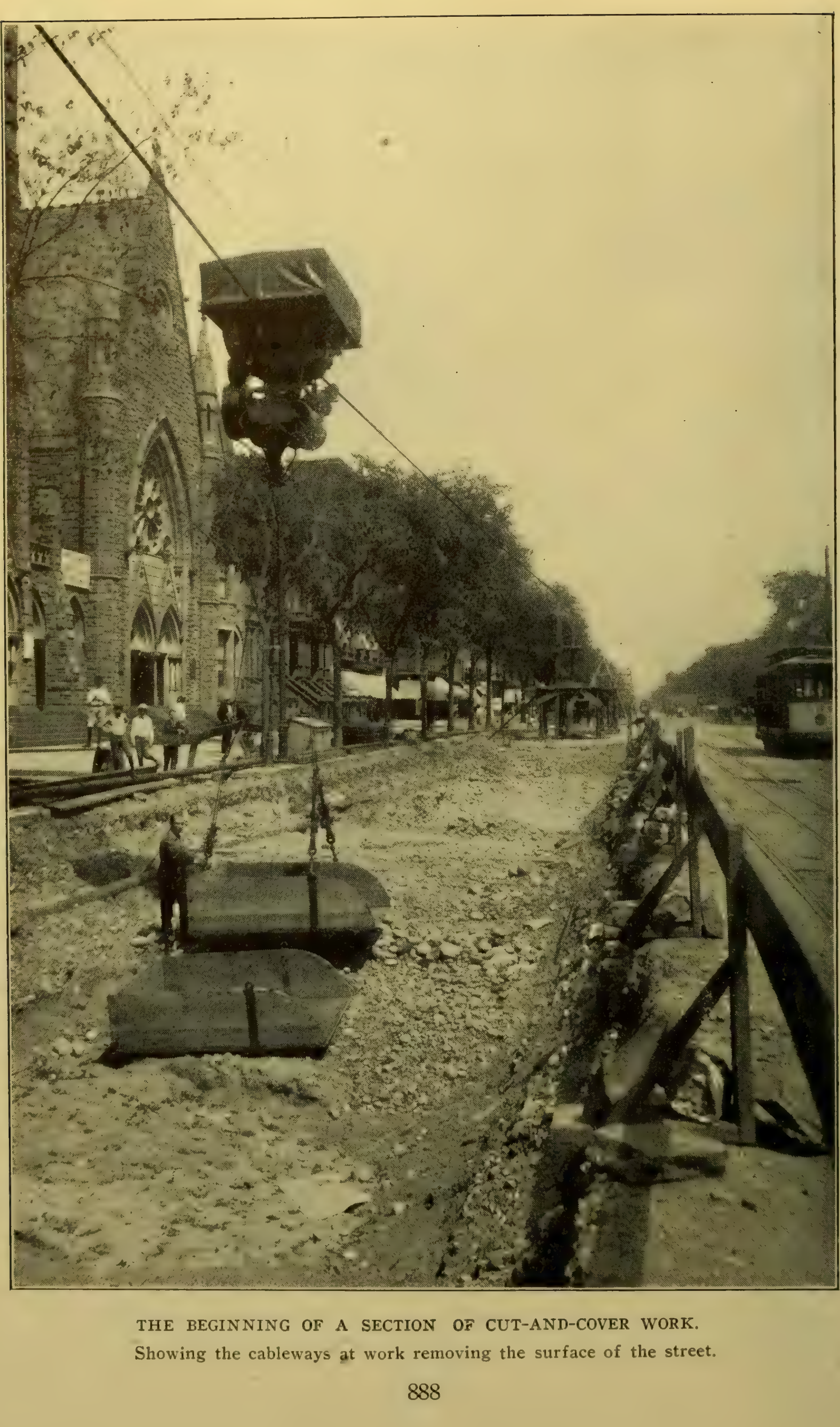
miles an hour; on the outer pair of tracks stations will be at much closer intervals, averaging four to the mile, the trains on these tracks attaining a speed of about 14 to 18 miles an hour including stops.

There will be two types of station—one a local station with platforms on the outside of the outer tracks and center tracks on which the express trains pass through without stopping. At the other type all trains stop, both express and local; at these stations a partial departure is made from the principle of adhering closely to the grade of the street, the whole railway being depressed sufficiently to permit the construction of a bridge over the four tracks, but of course *under* the street surface, connected with all four platforms by convenient stairways. If a passenger wishes to travel to a station where the expresses do not stop, he would leave the fast train at the station nearest to his destination and take a local train on.

Practically the whole of the subway lies immediately beneath the double tracks of the busiest electric surface lines and under some of the principal arteries of vehicular traffic. One of the conditions imposed upon the contractors was that there must be no interference whatever with the operation of the electric cars and the least possible obstruction to ordinary street traffic. It will be readily seen that the problem of carrying the electric tracks while the solid ground beneath them was being cut away was a very difficult one, and the means adopted for supporting the trolley tracks, and also the great mass of gas, water, electric and other mains while the earth and rock were being excavated, the steel built in place, and the concrete covering and the back filling and surface filling put in, deserve special notice.

In Park Row, for instance, the whole roadway was undermined without stoppage of the traffic, although there were four tracks of conduit electric cars on the surface and the sub-soil was entirely sand.

Advocates of the shallow subway pointed out that one of its chief advantages lies in the fact that all pipes, cables, mains, etc., can be re-laid in special galleries, thus avoiding the continual tearing up of the streets. When the New York subway was decided upon, it was realized by the engineers that there was a great opportunity for gathering all the city mains, conduits, cables, etc., together, and placing them in galleries constructed at the side of the rapid-transit tunnel. Plans were drawn for these galleries, and they were so arranged, with proper manhole openings at intervals, that whenever any repairs, laying of mains, or making connections to buildings had to be done, the gallery could be entered at the proper manhole and the work carried out without any disturbance whatever of the city streets. On



THE BEGINNING OF A SECTION OF CUT-AND-COVER WORK.

Showing the cableways at work removing the surface of the street.

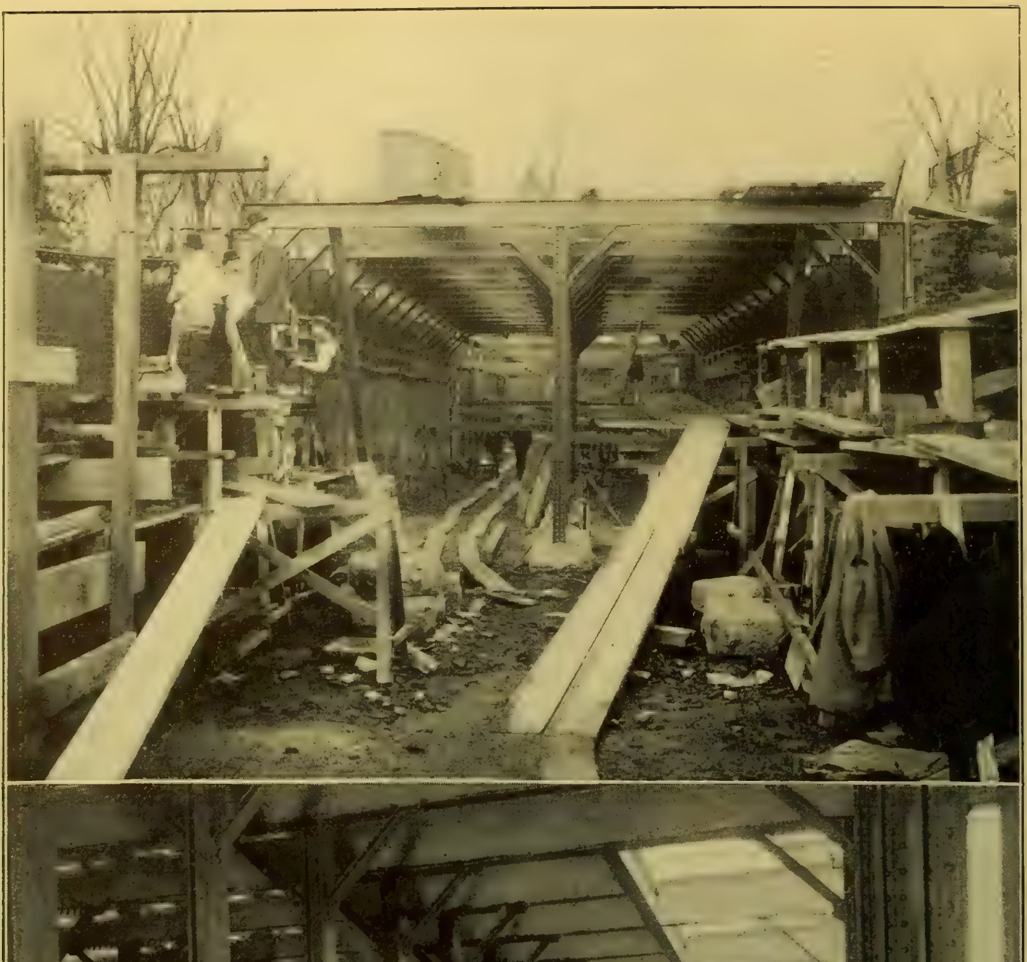
some stretches of the subway, excavation was made for these galleries; but owing to questionable moves on the part of the politicians who were in power at that time, two or three heads of departments raised a series of obviously absurd and inadequate objections to the plan, with the result that the rapid-transit commission, rather than become involved in a legal controversy that might seriously delay the work, decided to go ahead with the tunnel and drop the gallery scheme altogether. As a consequence the city mains have been spread over the roof of the tunnel, some distance below the surface of the ground, and it is pointed out that the city will continue to be exposed to the same interminable interruptions of traffic, which will be all the more exasperating because they could easily and cheaply have been avoided. Plans have been prepared for pipe galleries along the Broadway line leading to the Brooklyn tunnel. It is hoped that the city may be able to furnish the money necessary for the construction of these galleries.

Method of Construction.—The completed subway forms a steel structure rectangular in shape and built in an open tunnel.

The first step in its construction, throughout the greater part of its length, was to tear up the surface of the street and excavate it to the depth required, which averages about 20 feet. Then there was spread upon the bottom of the excavation a solid floor of concrete, and on this floor there were erected at intervals of about 5 feet, running transversely to the line of the street, frames of steel beams securely riveted together. These frames were to the structure what ribs are to the body, and they are designed to take up the load of the street and the thrust of the side earth. Between these frames or ribs there is built a concrete wall and a concrete roof, and between the tracks supporting the roof there are rows of light steel columns.

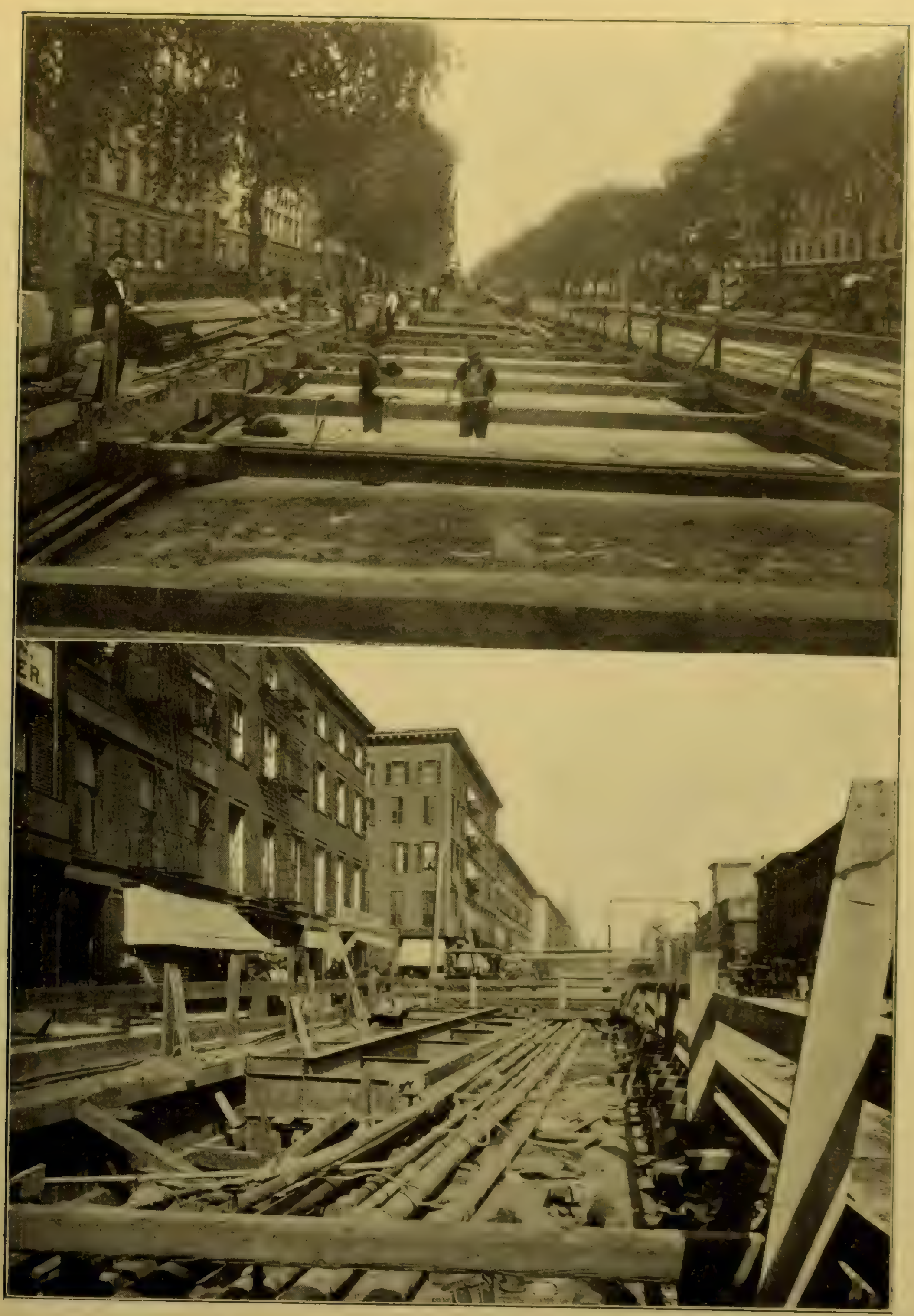
> "Sunlight during the day," says Mr. Parsons, "will have full play in the stations, lined as they will be with decorated tile, and with the railway in front with a flat roof the whole structure will suggest to the traveller what it is, in fact, a covered way. There being no smoke or combustion-producing motors the railway will be entirely free from obnoxious vapors; and as the stations will be at short intervals, and with large openings to the outside, there will be nothing of the nature of a close confined space, and therefore nothing giving the sensation of what is popularly known as 'cellar air.'"

The construction of the subway beneath Broadway will be, in general, similar to that employed on the rest of Manhattan Island, which may be described as a floor of concrete, with side walls and roof consisting of I-beams with concrete arches turned in between them, the



SUCCESSIVE STAGES IN CONSTRUCTION OF THE NORMAL SUBWAY.

In the upper picture, work is proceeding toward the background. In the middle distance the steel framework is completed and the arches turned between the verticals. The lower view shows the completed structure at a local station.

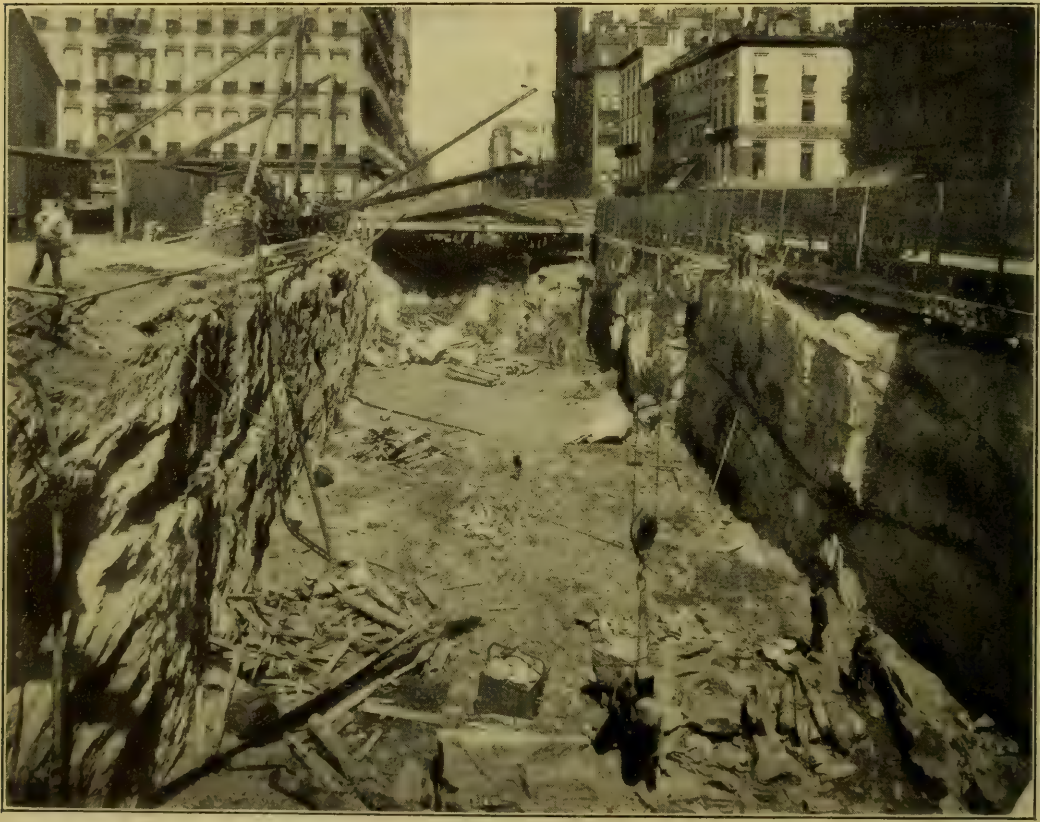


SECTIONS OF THE CUT-AND-COVER WORK APPROACHING COMPLETION.

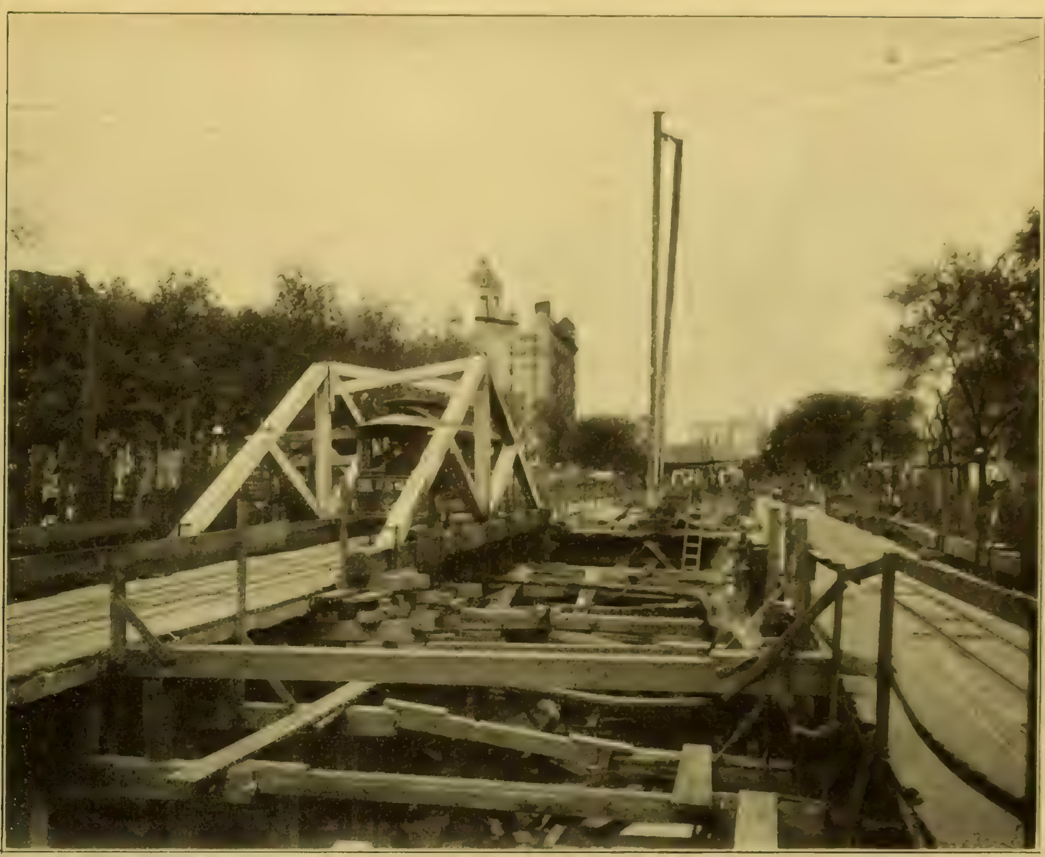
The upper view shows the roof of a finished section, seen from above, before the final filling in. In the lower picture a similar roof is shown with the various mains systematically relaid upon it, nearly ready for covering.

roof being supported on built-up steel columns, and the whole tunnel rendered waterproof by a complete envelope of waterproof felt put down in layers and thoroughly coated with tar. For the roof of the Broadway tunnel, however, a new system of construction, which has lately been adopted for the Lenox Avenue section of the road, will be used. This is what is known as reinforced concrete, the roof consisting of a mass of concrete with 1¼-inch square steel bars imbedded near its under and upper surface, the bars extending transversely across the tunnel and serving to give the necessary tensional strength to the concrete roof. This system of construction is more rapid and considerably cheaper than the old method of using transverse I-beams with concrete arches between them. The vertical I-beams of the side walls will be retained in building the road down Broadway, as they will prove valuable in affording lateral support for the careful shoring, which must be done in taking care of the foundations of adjacent lofty buildings during the process of excavation.

Supporting the Electric Tracks.—At the level of the street surface two pairs of 24-inch I-beams, 2 feet in depth and about 35 feet in length, were placed parallel with the tracks, one pair on each side



FIVE-TRACK EXCAVATION IN A ROCK CUT ON THE EAST SIDE OF UNION SQUARE, SHOWING THE CHARACTER OF THE GROUND UNDERLYING MOST OF THE CITY.



TRUSS CARRYING THE TROLLEY LINE, USED ON THE BOULEVARD WORK.

These trusses were moved forward as the construction advanced.

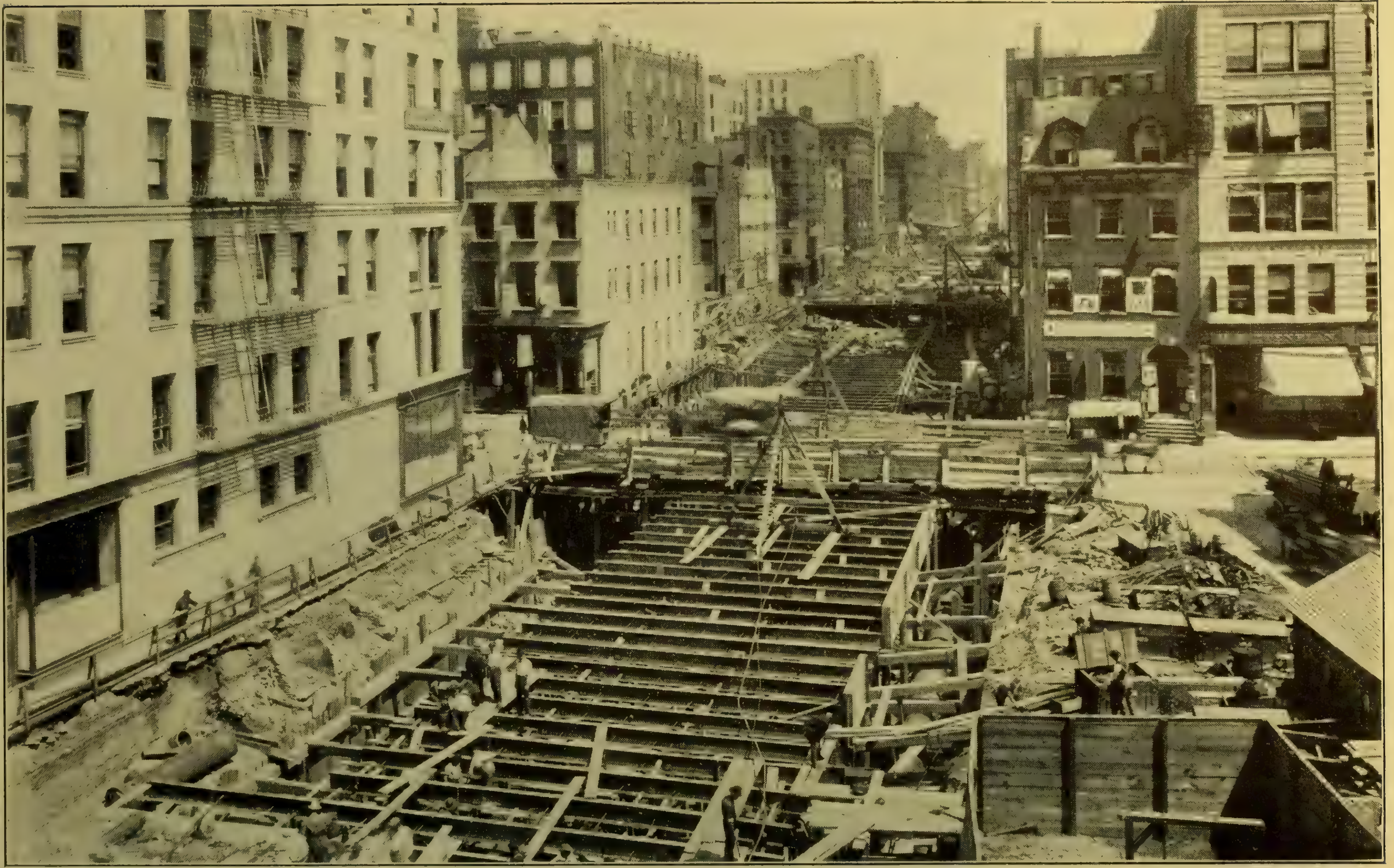
thereof. At each end of the I-beams, 12 by 12 posts were sunk to a firm foundation, and for the length of track covered by the I-beams the soil beneath the yokes carrying the tracks was dug out, and 12 by 12 timbers placed underneath them crosswise to the track. Heavy bolts were then passed up from the ends of the transverse timbers to the top flanges of the I-beams and drawn up snugly by nuts, the load of this stretch of track with the cars upon it being thus transferred to the I-beams. Similarly, 12 by 12 supporting timbers were placed from the I-beams to the adjoining sidewalks on either side, one end being bolted to the I-beams and the other resting upon the sidewalk flagging. The material was then excavated by pick and shovel, dumped into buckets of an overhead cableway, loaded into carts, and taken to some convenient dumping ground. The timbers extending from the I-beams to the sidewalks served to hold in place and carry during the progress of excavation the numerous water, gas, and electric mains, which lie immediately below the surface of the street. These were slung from the beams by stout chains, which held them securely in their proper level and alignment during the work of excavating. As the excavation was carried down, additional and longer 12 by 12 posts were put in place until sub-grade was reached. The foundation blocks and concrete floor were laid and the steel columns and the I-beams of the roof erected, the side walls and the intervening arches of concrete built in place, and the back filling rammed in, completing the work. As this filling was brought up to grade, the chains supporting the gas and water mains were unslung and the 12 by 12 timbers removed, the surface of the street being finally restored to its original condition. The steel framing is spaced about 5 feet apart longitudinally and answers in some sense to the framing ribs of a modern steamship. The concreting between the side-posts and between the I-beams of the roof is built in arched form to enable it better to resist the crushing pressure to which it is subjected.

Of the total length of subway now completed about half has involved the opening up of the streets; some four miles of deep tunnel work has been carried on without any considerable obstruction of the surface, while the remainder is an elevated structure. The "cut-and-cover method" (and New Yorkers say there is a great deal of cut and very little cover) involves the excavation of the tunnel, the erection of the steel framework, the building of the concrete roof and brick or terra-cotta sidewalks, the filling in of the excavation, and the paving or asphalting of the street surface.

Deep-Level Tunnels.—Of the deep-level tunnels that are being excavated entirely through rock, there are three principal sections. The first of these is the double tunnel, with two tracks in each, extending from Thirty-fourth Street to Forty-second Street. The next section of deep tunnel is that which runs under Washington Heights between One Hundred and Forty-fifth Street and the station at One Hundred and Sixtieth Street. The last section is between One Hundred and Sixty-first Street and One Hundred and Ninety-sixth Street.

Harlem River Tunnel.—The subway is carried under the Harlem River in a two-track tunnel. The method used in the present case was to drive two lines of sheet piling parallel with the line of the tunnel, and wide enough to enclose it; to construct a strong roof of timber across from wall to wall of piling; and then, by means of pneumatic pressure and air locks, exclude the water and excavate the soft mud from within the tunnel caisson and build the tunnel structure, which is constructed, part of it of concrete and part of it of cast iron, within the working chamber thus provided. The construction of the caisson involved the driving of piling throughout the full

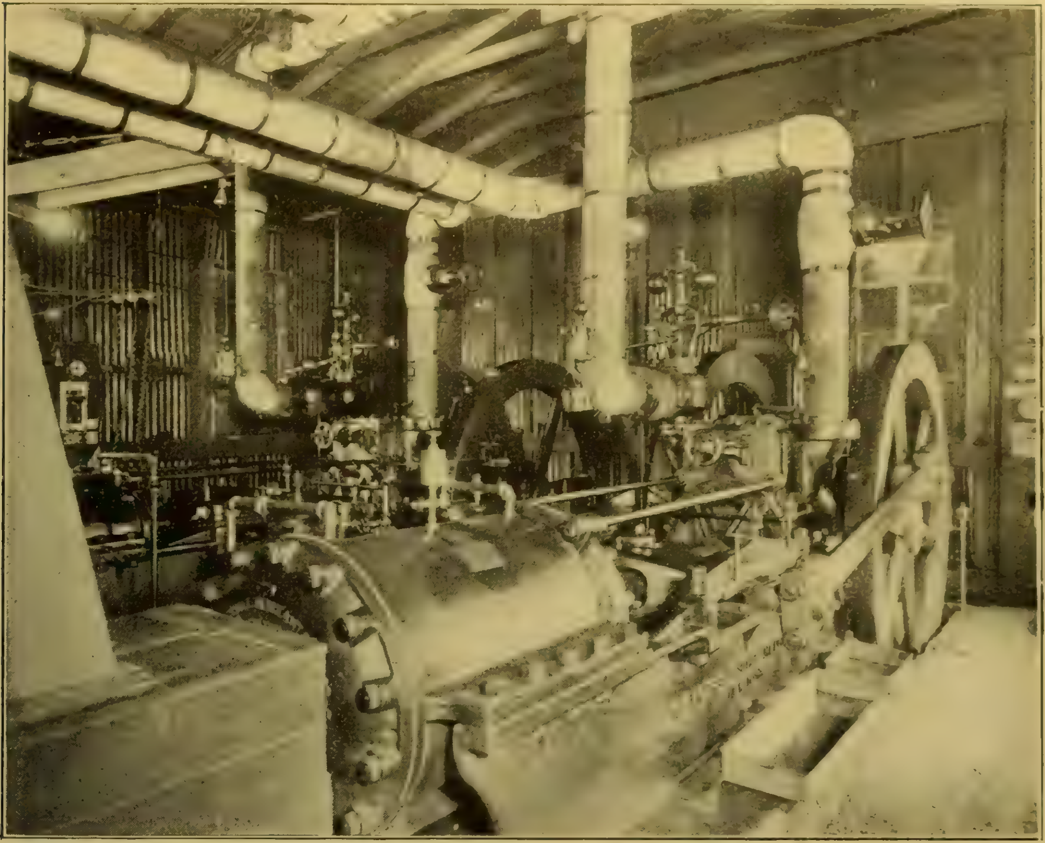
TUNNEL SECTIONS. THE UPPER VIEW IS AT THE PORTAL, ON THE NORTH OF CENTRAL PARK. THE LOWER IS IN THE TUNNEL ON UPPER BROADWAY.



CUT-AND-COVER WORK IN FULL PROGRESS, ON A MINOR STREET.

Elm street, not being one of busy traffic, was given up entirely to the subway work, no effort being made to maintain the surface.

length of the tunnel, and the piling, when cut off before commencing the construction of the tunnel proper, served to give a perfectly unyielding foundation upon which the completed work could rest, thus preventing the possibility of any future settlement.

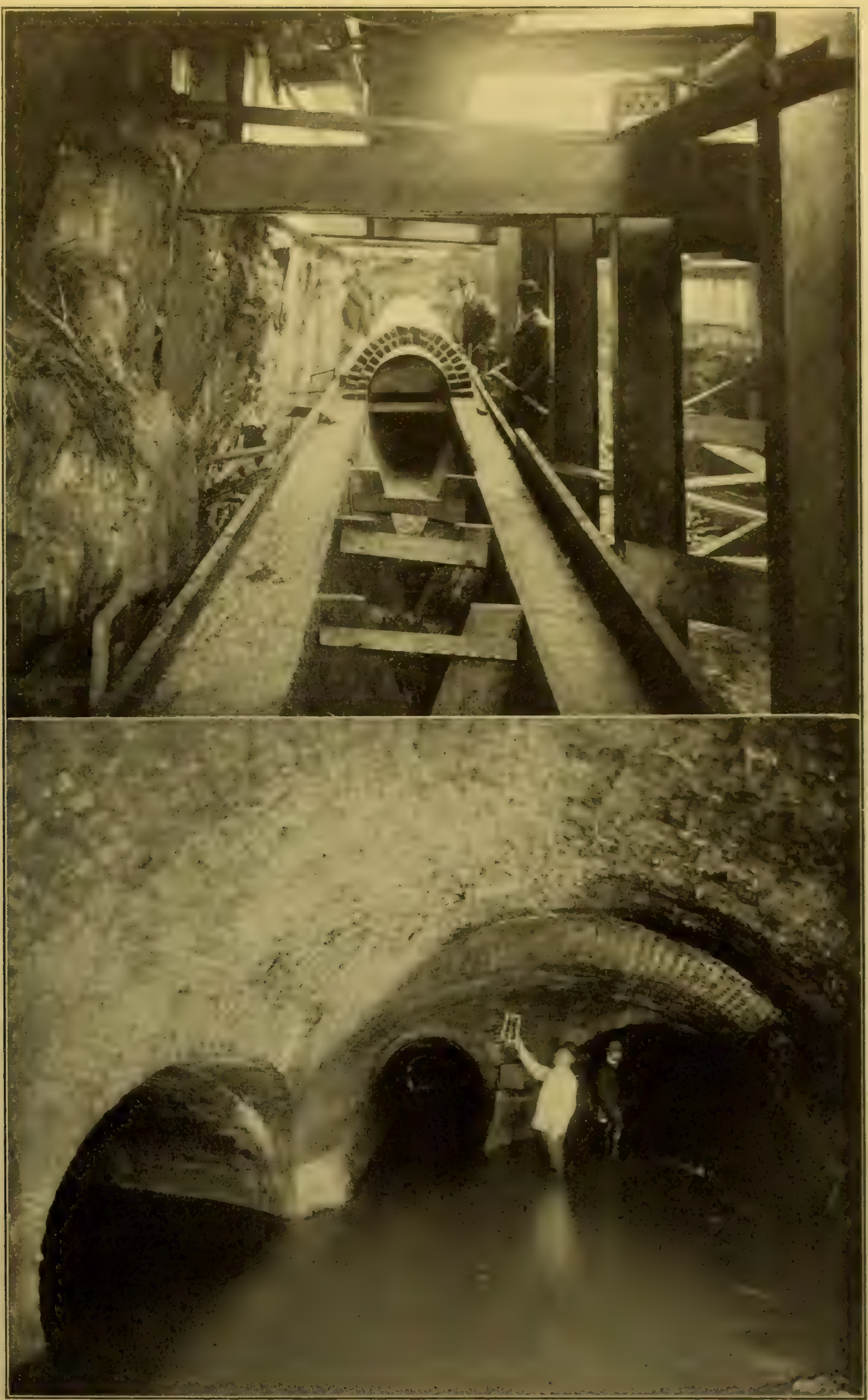


ONE OF THE MANY POWER PLANTS FOR AIR COMPRESSORS, ETC., USED ALONG THE LINE OF THE EXCAVATION.

Method of Construction.—In carrying out the work, the first step was to dredge out a channel to within about 6 feet of the subgrade of the tunnel. Piling was then driven for two lines of working platform, one on each side of the tunnel. Next the supporting piles for the roof of the caisson were driven, each bent containing four piles, and the bents being spaced eight feet from centre to centre. The duty of these piles was to support temporarily the timber roof, to assist in putting in place the transverse braces that held the side walls in line and to give additional bearing to the finished tunnel. To preserve the two sidewalls of sheet piling accurately in alignment, a pair of continual longitudinal trusses was used for each wall, the two trusses in each pair being spaced 12 inches apart, or the width of the sheet piling wall. To maintain the side trusses with their wall of piling at the proper distance apart, and preserve both walls in true line, a series of transverse trusses was constructed, which extended from wall to wall and reached almost to a contact with the longitudinal side trusses. With the combination of the longitudinal and transverse trusses with the rigid line of piling, it was possible by the judicious use of wedges at the ends of the transverse trusses to keep the side trusses and therefore the wall of piling very accurately in line. The grade of the tunnel was also accurately determined by moving the cut-off circular saw upon a track supported on the working platforms, and giving this track the exact pitch or grade required for the tunnel by moving the saw forward and maintaining always the same reach of the saw shaft. The cut-off of the piles necessarily presented the required grade for the finished tunnel.

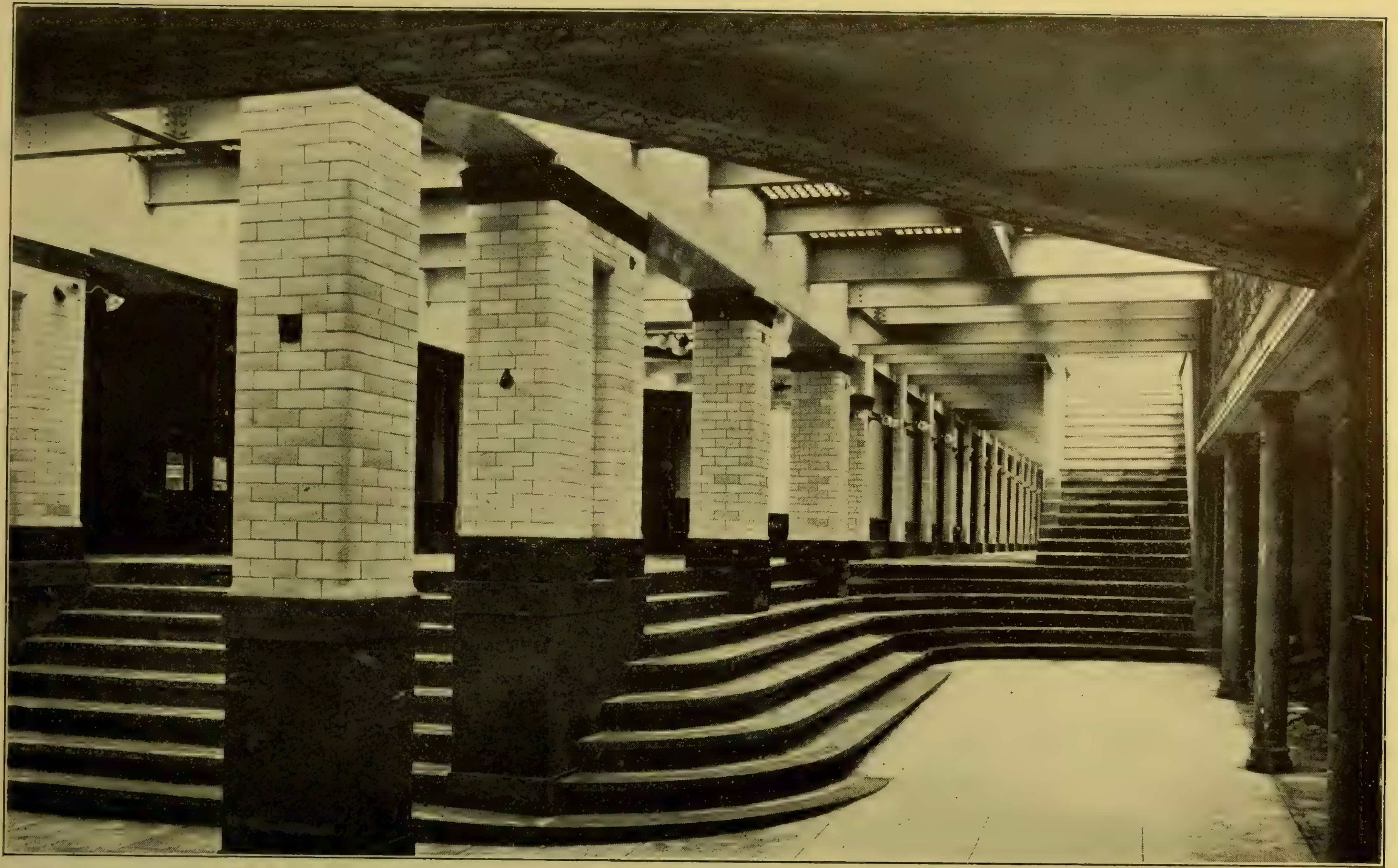
A PART OF MANHATTAN VIADUCT, DURING CONSTRUCTION.

The remarkable accuracy of the sheet piling and the tightness of the whole work is due very largely to the use of a compound pile which was designed especially for the work. This consists of three 12 by 12 sticks bolted together and driven as one pile, each threefold pile being tongued and grooved to the next pile; the work was also greatly facilitated by the use of pilot piles, which were built of



SEWER WORK, INCIDENTAL TO THE CONSTRUCTION OF THE SUBWAY.

The upper view shows one of the duplicate sewers, carried each side of the subway wall on certain sections. The lower is a large sewer intersection on One Hundred and Tenth St. The cost of sewer diversion is included in the contract.



TWENTY-THIRD STREET STATION. A POSSIBILITY FOR THE CITY OF THE FUTURE.

The space back of the pillars on the left is the sub-basement of a large office building. These lower stories, along the whole line, can be developed for useful commercial purposes.

steel channels and plates and measured 12 by 12 inches in cross section. These were driven with the aid of the jet, and served to open the way for the wood piling. Moreover, by their use it was possible to detect the location and contour of boulders, and when such boulders were struck, it was only necessary to withdraw the pilot-pile, blast out the obstruction, and drive the wooden pile.

The timber roof was built up of three transverse layers of 12 by 12 timber, and two intermediate layers of two-inch plank. The whole roof was well bolted and caulked, so as to make it water-tight. It was built in sections varying from 40 to 130 feet in length, floated into place between the working platforms, and sunk until it rested upon the top of the sheet pile. The joint between the roof and the sheet piling was closed by T-irons and a very satisfactory air-tight joint was secured. About 5 feet of mud was then dumped upon the roof, to keep it down in place with a firm bearing.

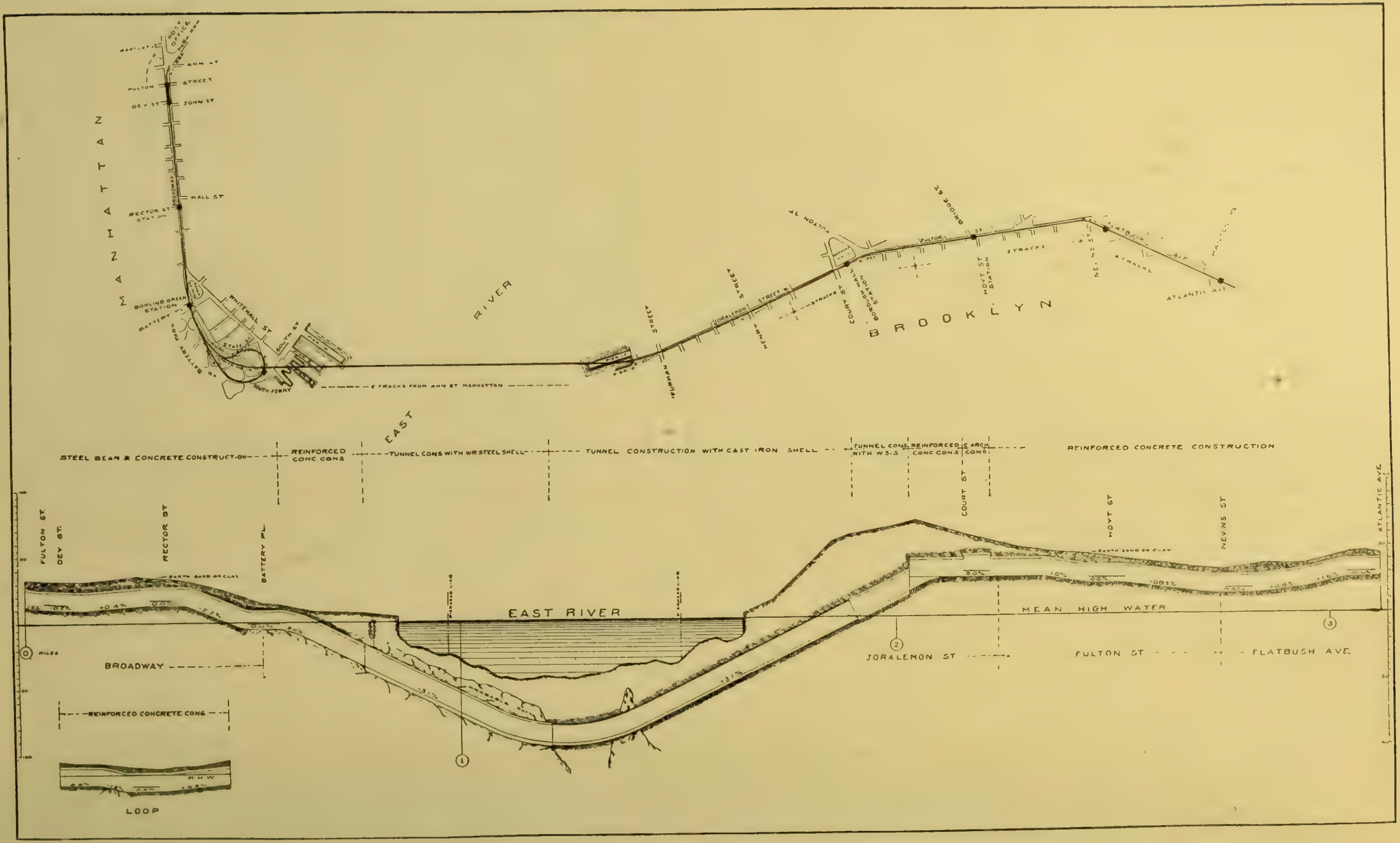
It was necessary to maintain the Harlem River channel navigation during the prosecution of the work, and consequently, only half of the river was closed at one time. This involved the enclosing of the work by two air-tight coffer dams. Near the centre of the roof of the caisson was built up a rectangular timber caisson with the usual air-lock, and in this were placed the pumps for taking out the soft material of excavation. Cylindrical iron material shafts were, of course, provided with the usual air-locks. An air pressure of 10 pounds to the square inch was sufficient for operation.

After the water had been lowered in the working chamber, the work of throwing out the mud and other material proceeded without any difficulties whatever, and when the excavation had been carried down to the desired level, the concreting of the floor was begun and carried up around the head of the piles.

These were then cut off, and spikes were driven into them, so as to give them a good grip upon the concrete foundation. After several feet of concreting had been laid, the cast-iron lining was put in place, the concrete carried up around it, and the tunnel completed. The upper length of the sheet piling was then cut out and the working platforms were removed.

The Harlem River tunnel was carried out by Messrs. McMullen and McBean and thanks are due to Mr. McBean for details supplied.

Brooklyn Extension.—The new section of the subway now under construction from City Hall Park, Manhattan, to Flatbush and Atlantic Avenues, Brooklyn, has been described as in some respects the most important link in the whole rapid-transit subway scheme.



OFFICIAL MAP OF THE EAST RIVER TUNNEL AND THE BROOKLYN EXTENSION OF THE SUBWAY.

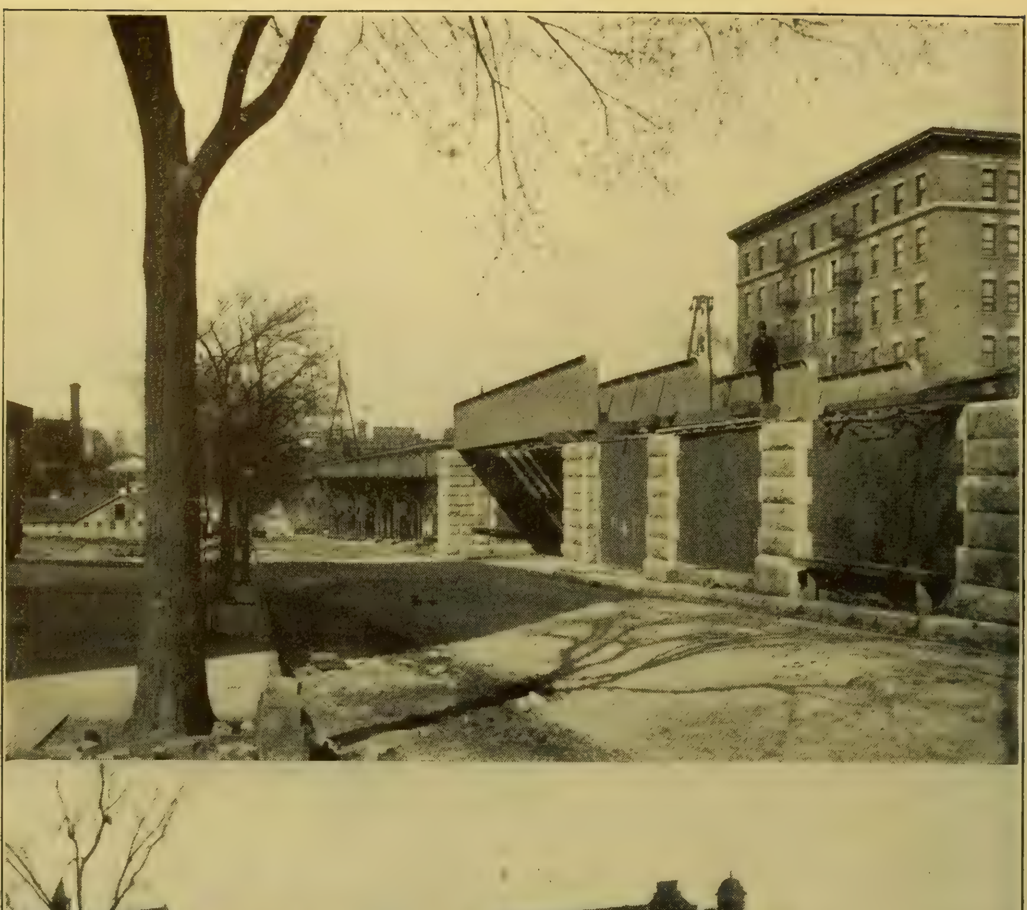
As the result of the introduction of a new system of construction for the side walls and roof of the subway, it is expected by the contractors that they will have the new line finished from City Hall Park to the Battery in a very short time. The tunnel beneath the East River will take about three years to construct.

The new extension, which will be a two-track structure, will start from the end of the present subway at the intersection of Park Row with Broadway, and it will extend beneath Broadway to the Battery, where there will be a loop for the use of the Manhattan trains, which will make the return trip to Harlem and beyond. On this portion of the line there will be four stations—at Fulton Street, Rector Street, Bowling Green, and on the loop at South Ferry opposite the Staten Island Ferry terminal. In some particulars the construction of the Broadway line will be similar to that of the subway already built.

The southerly end of the Bowling Green station platform will be located on the west side of State Street, about opposite the center of the new Custom House, and at this point will commence the terminal loop, which will extend below Battery Park. The station will be on the outer side of the loop, and in general will lie opposite the terminal stations of the various ferries that centre at South Ferry. There will be two tracks throughout the loop, the outer of which will be devoted to the through travel, the inner tracks being used for the storage of trains. At the point where the loop commences, the two tracks of the Brooklyn connection will switch off from the Broadway tracks and will be carried under the loop in a separate tunnel, on a descending grade to pass beneath the East River. These tracks will lie in a single tunnel until they approach the South Ferry station, when they will separate and each track will be carried in its own tube until Brooklyn shore is reached, when they will unite again in a single tunnel.

Considered as a transportation center, South Ferry, already an important point, will become one of the most important points of concentration in the world.

The East River tunnel tubes will descend on a grade of 3.1 per cent. until they reach the center of the East River, when they will rise on the same grade to enter Long Island beneath Joralemon Street. In Brooklyn, the subway will pass below Joralemon Street to the Borough Hall, where there will be a station; it will then pass beneath Fulton Street with a station at Hoyt Street, to Flatbush Avenue, where there will be another station, and will continue up Flatbush Avenue to a station at the junction of Flatbush and Atlantic Avenues. The tubes beneath the river will be built in sections of segmental.



WHERE THE SUBWAY EMERGES ONTO THE MANHATTAN VIADUCT.

The upper picture is taken looking north along the viaduct. The lower looks south along Broadway from a point slightly further down, and shows the buildings of the Teachers' College and Columbia University on the left.

heavy, cast-iron plates, with strong internal ribs, the sections being strongly bolted together as construction proceeds, and the completed tube being lined internally with beton, which is filled in flush with the inner edges of the ribs.

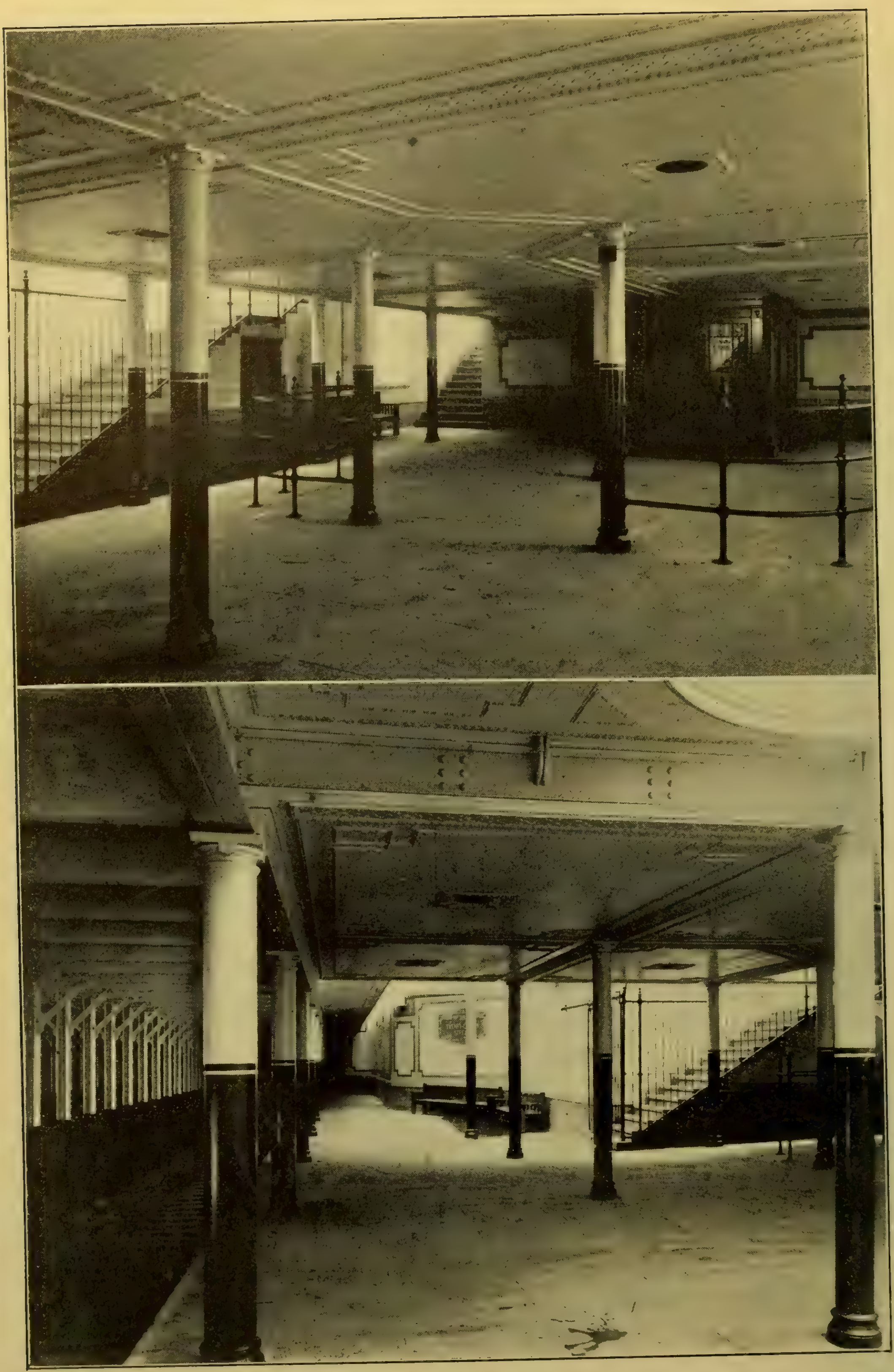
The New York Central and Hudson River Railroad Company can run two connecting tracks from their system at Forty-second Street, to connect with the subway under Fourth Avenue. By this connection the suburban trains of the New York Central, the Harlem, and the New Haven Roads, which are to be operated electrically, will be able to proceed to City Hall Park, or to the Battery, or to Brooklyn, as may be desired, and suburban residents living as far out as Peekskill, White Plains, and Portchester, will be enabled to travel from their respective homes to their places of business in New York or Brooklyn without change of cars.

The contract that was let for lower Broadway specified that the work was not to be commenced until the whole of the necessary structural material was stored in the yards of the contractors either in the City or within easy reach of the work. Not only was the steel to be so stored, but the paving blocks and excavating material, as they are taken up, are to be carted away and stored until such time as the contractors are prepared to restore the streets to their former condition. No derricks are permitted to be erected at street grade, but a platform has been built above the streets, resting on posts placed at the curb line, from which the whole of the work of hoisting excavated material and lowering structural steel, etc., is carried on. While there is a certain measure of inconvenience, it is slight in comparison with that which has attended the work now nearing completion.

A vigorous protest was made against the construction of a tunnel beneath upper Broadway, and the suggestion was made that instead of the "cut and cover" method the railway should be carried in a tube 60 or 80 feet below street level. The suggestion was not agreed to.

Extension of the Subway System.—The maps reproduced on pages 884, 885, and 902 show the principal subway schemes. Should the proposed extensions be carried out, the city will own a complete railway system covering 45 miles in the borough of Manhattan and the Bronx, with 135 miles of track exclusive of side tracks.

The first portion of the subway to be opened will be that from City Hall Park to the great underground storage yards at One Hundred and Forty-fifth Street, and on this part of the work there is a stretch of elevated viaduct which carries the tracks across the Manhattan Valley. The viaduct consists of a single arched span over One



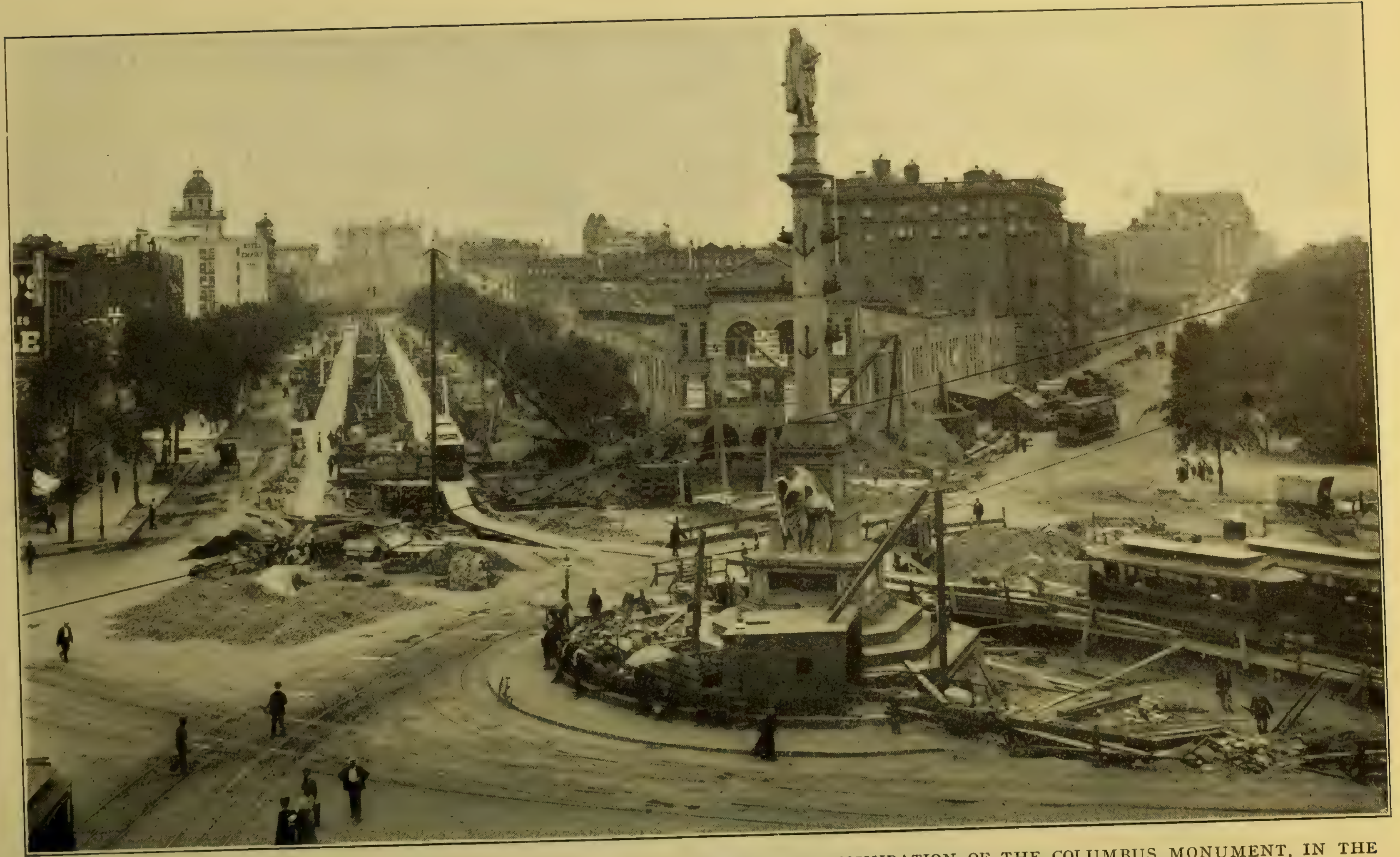
AN EXAMPLE OF STATION INTERIORS. TWO VIEWS ON THE PLATFORM AT TWENTY-EIGHTH STREET.

Hundred and Twenty-fifth Street, measuring 170 feet between the skewbacks, and a trestle approach on either side of it. The connection between the tunnel and the trestle at either end will consist of an open cut and a masonry embankment. The embankment will be faced with stone and brick, and finished with a massive stone parapet of pleasing design.

The stations are of two different types of construction. The City Hall Park station, for instance, is formed of arched concrete construction, while the roof of the Circle station is carried on steel columns and girders with concrete roofing turned in between the girders. In both cases the stations are well lighted by overhead sidewalk vault lights, assisted by a liberal use of incandescent electric lights. The finish of the walls is in glazed tiling, the colors being chiefly white, green, and Venetian red. The names of the stations are shown in large glazed tile letters set in the panels of the wall, and they will be clearly distinguishable by the passengers. The loop tunnel will contain a single track, and the station platform, and indeed, the whole station, is on a curve of somewhat sharp radius. The Circle station, being on the main line, will contain four tracks. An interesting feature of the Circle Station is the fact that the structure cuts in underneath the Columbus statue, which is over 75 feet in height and weighs about 724 tons. During excavation a pair of heavy steel girders was placed beneath the corner of the heavy base of the statue and carried on two temporary timber bents. The steel work was then built in place and concreted up, the temporary girders and bents were removed, and the surface restored to its original condition. To prevent sliding in of the old foundation, a new foundation of rubble was carried down at the side of the subway excavation and left permanently in place when the subway was completed. This monument is shown on the next page.

The Power House.—The great power house is situated on the Hudson River between Fifty-eighth and Fifty-ninth Streets and Eleventh and Twelfth Avenues. Nine 8,000-horse-power engines, direct-connected to 5,000-kilowatt generators, will form the initial equipment, the power-house property being large enough to admit of additions as there shall be a demand for them. About six hundred cars will be called for at the opening of the line. The specifications called for a multiple-control system, three cars out of five, or five cars out of seven or eight in a train, being motor cars. A contract was let to the Pennsylvania Steel Company for 10,000 tons of rail, weighing 100 pounds to the yard.

The power-house building covers a plot of ground 200 feet in width



THE EXCAVATION ON BROADWAY, LOOKING NORTH FROM THE CIRCLE. THE FOUNDATION OF THE COLUMBUS MONUMENT, IN THE FOREGROUND, WAS PARTLY UNDERCUT AND REBUILT TO ACCOMMODATE THE SUBWAY CONSTRUCTION.

by 700 feet in length. A fair idea of its size is gathered when it is stated that it is nearly twice as large as Madison Square Garden. By the time it is fully equipped, it is estimated that its cost will have reached $7,000,000. When the complete plant has been installed and the station is working up to its fullest capacity, the combined power of the engines will reach the great figure of 120,000 horse power. The great coal bunker, which will be constructed immediately beneath the roof and extend the full length of the boiler room, will have a capacity of 25,000 tons, sufficient, if it were completely filled, to run the plant continuously for nearly a month. The coal will be brought to the docks at the river end of the building, where it will be raised by belt conveyors in an elevation of about 80 feet above the street, carried for the full length of the bunkers, and automatically dumped wherever it is required. From the bunkers it will be drawn off by gravity through chutes which terminate above the furnace doors. Here the coal will be delivered into the hoppers of the mechanical stokers, and after it has done its work in the furnaces, the ashes will be mechanically dumped at the rear end of the furnace into hoppers, through which they will flow into ash-cars, which run upon tracks to the river; there the ashes will be unloaded into scows. A remarkable feature of the building, by which indeed it may be easily recognized, will be the five great smoke-stacks, each 265 feet in height, and a novel feature in the construction of these stacks is that, instead of the chimneys extending completely down to ground level, they will be carried by massive steel platforms which will extend 40 feet above the floor of the power house. This is done to save a large amount of valuable space which has hitherto been monopolized by the square base of such chimneys. The building is of the usual steel and masonry type. The architectural features promise to be pleasing and appropriate to the size and character of the structure. The exterior wall consists of cut granite up to a certain level, above which it is built of terra-cotta and pressed brick, while the interior is lined with chocolate and cream-colored brick for the first two stories and above that with an attractive shade of buff brick.

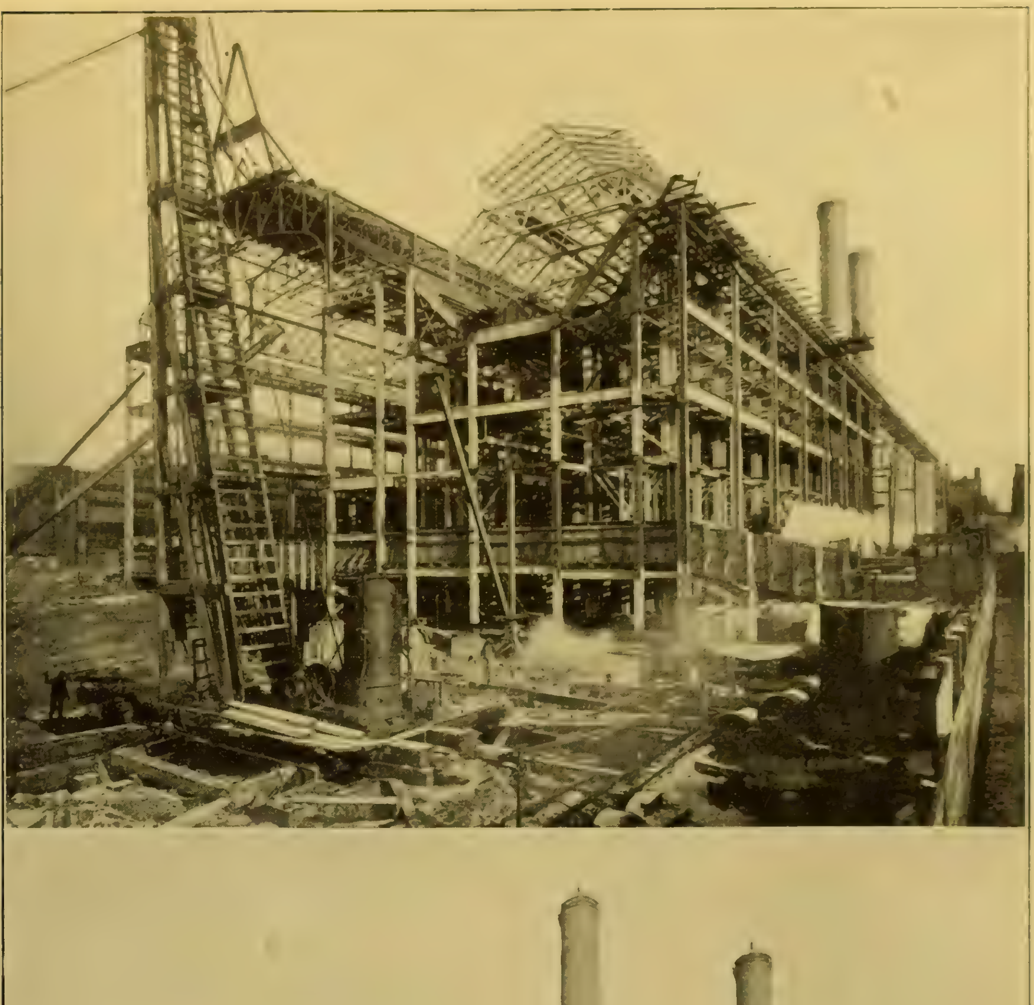
Electric Motors for the Trains.—The Interborough Rapid Transit Company will operate two classes of train service. The first will consist of five-car local trains, composed of three motor cars and two trailers, making an average speed of approximately 16 miles per hour. The second will be eight-car express trains, comprising five motor cars and three trailers, making an average of 25 miles or more per hour; the same motors and gearing will be used for both classes of service. The motors, which are to be supplied by the Westinghouse Electric and Manufacturing Company, were designed especially for this purpose, and were made to fit the particular conditions and requirements involved; one of those requirements, and perhaps the most difficult, made necessary the designing of a motor of large capacity to fit into a limited space. As a result, the present motors are probably of smaller size for their output than any built heretofore.

The nominal capacity of the motors is 300 amperes at 570 volts, or 200 horse power. With this current and voltage, a tractive effort of 4,150 pounds is developed at the periphery of a 33-inch wheel, at a speed of 19 miles per hour. Although designed for an average voltage of 570, the motor will operate satisfactorily with voltages up to 625. It will carry loads up to 500 amperes without injurious sparking.

The motor has a field frame of cast steel, divided into halves on the line of the centers of armature and axle, and completely surrounding the axle. There are thus no separate axle bearing caps, and the number of pieces is consequently reduced to the least number possible for an easily accessible motor. The top half of the field can be readily lifted off and access gained to the interior for inspection and repairs.

The four pole pieces are made of laminated-steel punchings held between heavy end plates and secured by rivets. The field coils are made of copper, strap wound on edge. The insulation between turns consists of asbestos and mica, held in place by shellac and baked at a high temperature under heavy pressure, so that the coil and insulation make a solid mass. The completed coil is sealed in a curved metal case, from which it is insulated by moulded mica made like the V-rings of a commutator. This construction gives a coil which is absolutely fire-proof, moisture-proof, and practically indestructible.

The armature is 20 inches in diameter and weighs 1,930 pounds. It is of the slotted drum type, and is composed of sheet-steel punchings assembled on a cast-iron spider. The commutator is also carried on the same spider, and the shaft may thus be removed and replaced, should this ever become necessary, without disturbing the armature winding or its connection to the communator. The winding itself is of the two-circuit type, and is of ventilated construction. There are 53 slots and 159 coils, i. e., three coils per slot. Each coil consists of a single turn of copper strap. The coils are held in the slots by wedges of special unshrinkable material, which will withstand a high degree of heat without injury. This is a valuable feature, and gives a construction which is stronger and safer than the use of bands. It also greatly facilitates the removal and replacing of the armature



THE POWER HOUSE, DURING CONSTRUCTION.
Views taken early in the current year.

coils. The armature insulation consists essentially of mica, which extends between turns at all points. The mica is protected by a sufficient amount of fibrous material to insure against deterioration due to mechanical vibration. This fibrous material is treated with a moisture and oil-proof compound, forming an insulation capable of withstanding very high temperature without injury. The commutator is composed of 159 rolled and hard-drawn copper bars, held in place by two steel V-shaped rings, one of which serves as an oil guard to protect the mica thoroughly from oil or grease. A low voltage between the communator bars is secured, decreasing the liability of flashing from any cause. The bars are insulated from each other by sheets of mica of a hardness that insures their wearing at the same rate as copper.

The brush holders consist of two cast-brass arms, each carrying three carbon brushes 5/8 inch by 3 inches in section. The brushes slide over finished surfaces, and each is pressed on the commutator by a spring finger. The tension of these fingers is readily adjustable, and the brush-holder arm is arranged for radial adjustment to allow for wear of the commutator. Copper clips are bolted to the carbon, and these clips are connected by flexible shunts, of ample capacity, to the body of the brush holder, thus relieving the springs from carrying the current.

The completed motor will stand an insulation test between winding and motor frame of 4,500 volts alternating momentarily, or a test of 3,000 volts for one minute.

The armature bearings are contained in housings which are securely held between the halves of the field frame. These and the axle bearings are lubricated by oil fed to the journals by waste, in accordance with standard railway practice. The oil boxes are formed so that the waste will pack itself against the journals.

The gears are solid, of cast steel, with cut teeth. The pinions are forged steel with cut teeth. The gear-case is made of malleable iron planed to a tight joint, with a suitable opening at top having a hinged cover. It is supported at the ends by horns cast on the motor frame and so shaped that they support the gear case without side strain, the weight being carried in its own place. The whole motor can be dismantled with great ease and without the use of any special tools. Its total weight including gear, gear-case, etc., is about 6,600 pounds.

THE INTRODUCTION OF HIGH-SPEED STEEL INTO A FACTORY.

By A. D. Wilt, Jr.

Practical men often say that the engineering literature they want most is that which tells not only what to do, but how to do it. Mr. Wilt's contribution admirably fulfils this requirement in its definite description of the mode of preparing and handling high-speed-steel tools. A following paper will take up the management problems connected with their introduction and use.—The Editors.

THOUSANDS of dollars have been indiscreetly spent by some manufacturers in the introduction of high-speed steel into their plants. This is the case where too little systematic attention has been paid to its proper use. In factories which produce a variety of parts, the question as to whether or not it is better to use carbon-steel than high-speed-steel tools is one which in most cases can be decided only by a systematic study. And after its use is decided upon, many problems confront the alert manufacturer in introducing high-speed steel; in this review they will be discussed in the order in which they were met in factories with which I have had experience.

The first step taken in trying out some lathe tools, submitted by several different steel promotors, proved so successful that four or five different kinds of tools were made from as many different brands of steel, and these were promptly ruined by improper hardening. Realizing that the success or failure of the use of this steel lay in the hardening more than in any other feature, the first general question met was,

I.—Can high-speed steel be hardened successfully in tools of all shapes or sizes?

Some milling cutters of a small size were sent to the promotors of the steel to be hardened. Although the hardening was done properly and the tools worked successfully, it was not well settled that they paid, because the output, which increased somewhat, was limited by such factors as the speed of the machine and the condition of the part after having been operated on at increased speed. This brought up the following questions.

II.—What factors besides the successful hardening of the tools must be considered to obtain the highest efficiency from the use of high-speed steel?

III.—What is the best plan for introducing high-speed steel into a factory?

These questions, in general, confront every thinking manufacturer who realizes the great possibilities of this steel. Although much information can be obtained from the experience of others, many vital problems must be solved in each individual shop. The following discussion is the result of observations made of the use of high-speed steel and the machinery on which it is used in many prominent factories. No definite rules can be laid down, owing to the varying conditions in each factory; only prevailing practices will be proposed. The following pages will deal with the mechanical aspects of the problem—that is, the treatment of the steel and the handling and operation of the machine tools in which it is used. A succeeding article will take up the management problems and the record systems and forms for adapting piece-rate or premium systems to the changed conditions of working brought about by the new tools.

I.—Can High-Speed Steel Be Hardened Satisfactorily in Tools of any Shape or Size?—Tools made from high-speed steel are in extensive use, in sizes and shapes ranging from the smallest watch tools to the largest milling cutters. The consensus of opinion of many blacksmiths is that the forging and treatment of high-speed steel is much simpler and is accomplished with less risk than attends the same processes in the case of carbon steel.

As the composition of each brand of steel is different from that of other brands, it is no easy problem to determine the proper temperature to which a tool must be subjected. Every brand of steel has its distinct formula for heat treatment prescribed by the producer. In a number of different factories using the same brand of steel, as many different processes of heat treatment were pointed out by their respective blacksmiths as the best; they were possibly the best for their own particular use. How best to harden a tool for a specific use can be determined only by systematic and scientific experimenting.

Too little attention is paid in the average factory to the blacksmith shop. Its importance as an agent for greatly increasing production is carelessly overlooked. Some manufacturers have never reaped the full benefits from carbon steel because they have never provided means for recording results from constant experimenting, but have entrusted the keeping of most valuable data concerning the very essence of production—the tool—to the memory and eyes of their blacksmith. When he leaves them he carries with him information concerning their business which cannot be regained for years by his successors. It is now an established fact that there is one critical temperature for each composition of steel which will give the best results, and that a small deviation above or below this particular temperature will greatly affect the life of the tool. The long practiced method of judging by the eye can no longer be relied upon to give correct temperatures, and is not advisable with the advent of high-speed steel, especially where large quantities are hardened. The reason is that the eye is affected by exposure to continued high and bright heats. In one factory in which I had experience no blacksmith is allowed to harden high-speed steel more than two hours continuously, and no other steel within two hours after that. Acccurate and reliable methods of determining temperatures must be employed, and records kept, if experimenting is to be profitably done; without these exact and definite data, available in tabular or graphic form, comparison is impossible.

Although high-speed steel is still in the experimental stage, it is produced with very little variation in its composition. At any rate, the changes in composition of any well-known brand are not so great that a record of the heats applied to tools made from it would be unreliable in deciding, without chemical analysis, the heat that should be applied to later made tools of this same brand. If the blacksmith is to profit by experimenting he must know how the tool stands up. As some high-speed steel tools last a long time, it would be impossible for him to remember the heat applied to such tools without the aid of some heat measurer. He might remember the type of furnace used and the cooling process, and possibly the temperature to which the tool was drawn, but this is doubtful where many tools are used.

There are several methods now in use for determining the heat of a furnace, or the heat received by a part—among them the pyrometer and the thermal gauge. It is a question whether such instruments read accurately after they have been used a number of times, but any change can readily be detected by the user. Where great accuracy is required it is best to equip the furnace with two methods, one to serve as a check upon the other. If the greatest accuracy is desired, the heat measuring should be accompanied by a chemical analysis of each bar of steel. In most cases this is impractical. After one brand of steel has been in use some time an expert blacksmith should have no trouble in hardening any tool properly with the heat-measuring appliances, and where four or five different brands of steel are used, or where the initial use is being made of one or more brands, these are of greatest help. The difficulty lies in persuading the blacksmith that such instruments produce results which would warrant his bothering with them, for they demand much attention compared with the old "hit-or-miss" method.

Some observations are herewith given of the most common methods employed on certain classes of tools.

A. Lathe, Planer, and Other Tools Requiring Only an Extremely Hard Cutting End.—In most factories this type of tools is hardened in an open forge—in a few cases, in small gas bench forges. The usual practice is to heat forged tools to a bright cherry, then grind down while hot on a dry surface to the required angle, and cool slowly in the open air. They are generally laid with the edge over a table until they become cold, and are then heated to nearly a fusing point and cooled in an air blast. In fact, all tools of this type are generally cooled in an air blast, preferably compressed, the tool being held at least five inches from the mouth of the blast. Sometimes they are reheated slightly to relieve the forging strain. It is not customary to draw the temper of this class of tools, but I have seen remarkable results from drawing them to a straw color. In a few cases, such as drills for certain uses which are hardened only on the end, they are cooled either in air to a good red heat and then in oil, or entirely in oil.

B. All Other Tools Requiring Hardness Throughout, not Including Punches and Dies.—It is the general practice of most blacksmiths to harden all other tools, such as milling cutters, in a gas furnace, and cool in oil. In some cases they are hardened in a forge, or in lead, and sometimes cooled in the air blast. It is my opinion that gas furnaces are the best in which to heat high-speed steel, from the fact that no flame impinges against the tool, that the heat can be more readily seen, and that the cutting edges of the tool do not come in contact with a hard surface. Chiefly for the last reason the cylindrical gas furnace is in most cases better than the gas oven.

All tools that can be suspended can best be hardened in a cylindrical furnace, this applying particularly to milling cutters, drills, reamers, etc. Drills, reamers, and long tools in general should be suspended in a vertical position. Most tools can be suspended by using heavy wire hooks, or by clamps. If the tools can not be readily suspended, a gas oven is best. The latter is used more extensively in heating large milling cutters, such as spirals and face mills. As has been pointed out, the greatest advantage of cylindrical over oven furnaces is that the work does not come in contact with any hard surface.

Another feature of the cylindrical type is that the heat can be applied slowly throughout by the method which follows, and the tool not plunged cold into a very high heat, as is the case when the gas oven or forge is employed without extra arrangements for preliminary heating. This is accomplished by first placing the tool on top of the furnace until it comes to a dark cherry red heat, and then suspending it in the furnace. No time is lost by this method; for while one tool is directly exposed to the high heat another can be heating up slowly on top of the furnace. The reason that some blacksmiths prefer the oven to the cylindrical furnace is their lack of experience with the latter. It is true that the cylindrical furnace is harder on the eyes.

Whether or not tools of this class are better when the temper is drawn can be determined only by experiments. No specific drawing temperatures can be prescribed, but, in general, when this is necessary it is safe to draw the temper of certain classes of tools as follows:—drills to 475 degrees F.; taps to 525 degrees F.; milling cutters to 450 degrees F.; and threading dies to 525 degrees F. A method of discovering the proper temperatures is proposed elsewhere.

C. Punches and Dies.—Manufacturers do not seem to be so well assured of the benefits derived from using punches and dies made of high-speed steel. Although some wonderful results have been obtained from certain kinds of punches and dies, it is not so certain that they pay in all cases. In ordinary work, carbon steel will last a long time. This makes necessary a consideration of whether or not the part is liable to be changed in that time. Another consideration is the possibility of there being a flaw in the metal due to improper treatment. Owing to high cost and uncertainty of structure, it may not always be safe to use high-speed steel for this purpose. Some phenomenal results have been obtained from small round punches, such as those used for boiler plates, etc. In fact, high-speed steel is being used extensively in large dies, but nevertheless there is a question as to whether it pays in all cases. It is a good plan to harden high-speed steel dies in a gas oven, the temper being drawn to about 600 degrees F.

A useful accessory to hardening is an oil tank placed in a larger tank arranged for a supply of flowing water. A current of air is sent up through the bottom of the inner tank and through the oil. This not only aids in cooling the oil, but in keeping it at a uniform temperature throughout. Ordinarily the hot oil rises to the top of the can and retards cooling where only the end of the tool is to be dipped.

It is sometimes desirable, preparatory to hardening, to re-anneal tools having fine edges or delicate projections and recesses, in which sudden unequal expansions or contractions are liable. This relieves strains incurred in machining, and brings the steel to a normal condition, thus insuring uniformity in the hardening process.

The customary method of annealing is to cover with powdered charcoal and heat in hermetically sealed boxes, for a period varying with the size, at a temperature near 1,800 degrees F. The pyrometer can be used with great advantage in ascertaining the proper annealing temperature.

II. What Factors Besides the Successful Hardening of the Tool Must Be Considered to Obtain Highest Efficiency from the Use of High-Speed Steel?—It is obvious that to increase production greatly a machine must be proportionately speeded up. A few experiments will demonstrate that a high-speed steel tool is capable of being run at a higher speed than many of the old types of machines will permit. In many cases heavier machinery is necessary, and in some cases lighter machinery. With few exceptions, provision must be made for increased speed.

Not only is it necessary to have improved machinery and stronger tools to get an increase of production with high-speed steel; we must secure also conjoined co-operation on the part of the workman. Without this co-operation the chief gain from using high-speed steel would be in its durability. To get the conjoined action of the workman, it is necessary that he be given some incentive to get the highest possible output from the machine; but even if he has this ambition, he can not obtain what he should if he guesses at the speed or feed to be employed on any piece of work. So we have, in general, three factors besides the steel and the tool itself entering into the increase of production, namely:—

1. Improved processes and machinery.
2. Ambitious workmen.
3. A means of ascertaining from daily experience the most economical way in which to remove stock.

1.—A revolution in machine design has begun within the last three years among wide-awake manufacturers, who have realized the possibilities of high-speed steel. The outcome has been the production of some most creditable machinery. Some marked changes are observable in the following types of machinery:—

A.—Lathes, Planers, Boring, Slotting, Threading, Cut-off and Other Machines of This Type.—As a rule heavier machines are employed to do lighter work with high-speed steel than formerly with carbon. A great many companies have produced a lathe geared altogether differently from any previous type. In general, heavier machines with increased speed are used on lighter work. The tools are not always heavier. It seemed a problem as to whether tool holders would be profitable with high-speed steel, and also whether the cutting angles of the tools should be changed. Some manufacturers are grinding their tools at angles different from those used on carbon-steel tools. A saving in high-speed steel can be effected by using it only on the cutting end of this class of tools. It can be welded readily to carbon steel.

B. Drills.—It is a question among a few manufacturers as to whether high-speed drills in sizes under 1/2 inch, but it has been my experience that they can be used with great advantage in size as small as 3/16 inch. This, however, does not apply to all brands of high-speed steels. High-speed drills in sizes over 1/2 inch are certainly better than carbon. Instead of heavier presses, which one would think necessary for increased speed and feed, one of much lighter type has been constructed which does wonderful work. It is built with any number of spindles for heavy or light work as might be required. As the press has ball-bearings throughout, the friction is greatly decreased, allowing greater speed without heating. Where the main spindle slides up and down through the cone pulley it has two splines with rollers in place of a key. I saw, with this press, a 7/8-inch hole drilled through a block of cast iron 1 3/8 inches thick in 15 seconds. The machine was run by a 1-inch belt. This press has not yet been constructed for extremely large drills, but it should be practical in almost any size.

C. Automatic Screw Machines.—The tendency seems to be to use heavier machinery to do a lighter class of work. Radical changes are not as noticeable in this class of machinery, however, as in most others. Heavier tools are used where high speed is possible. Most of the old types are capable of being speeded up a great deal.

D. Milling Machines.—Some manufacturers of this class have had to entirely reconstruct their machines. In most cases provisions have been made for an increase of speed, accompanied by greater strength to overcome vibration as well as wear. In some cases the ordinary type is capable of taking care of as great a speed as the part operated on will permit. High-speed-steel milling tools seem to be more efficient with a greater number of cutting teeth than were formerly used in carbon-steel tools.

Besides improved machinery there are several factors which must enter conspicuously into the use of high-speed steel. Important among them are automatic magazine feeds. Where formerly the tool in many cases limited the output, it is now limited by the endurance of the workman. Automatic magazine feeds are in use on such machinery as turret lathes, drill presses, punch presses, screw machines, and even milling machines. As a rule they must be constructed to suit local conditions.

It is to the interest of every manufacturer using high-speed steel to devote attention to their use, and if necessary to consult experts in this line.

Another most important factor is compressed air. Its chief advantage is in blowing away chips which, if not removed, are formed with such rapidity as to injure the tool. A very interesting form of the automatic screw machine has been constructed which operates almost entirely by compressed air. It is used with great advantage on numerous fixtures, such as chucks and drill jigs. Its value in jigs lies in its ability to instantaneously tighten any number of clamps. In fact, its chief advantages are its simplicity and its quick action. Its disadvantage is its cost. Conjoined operation of compressed air, automatic magazine feeds, and high-speed steel is a royal road to cheapened production.

2. The problem of interesting workmen in increasing their output is a subject too broad for this article.—It belongs, indeed, to shop management generally, and exists wherever tools are used, whether of old types or new, though of course it becomes more acute as the possibilities of extremely rapid production are increased. In general, to attain the maximum of interest to the workman there must be, besides fast tools, a good piece-rate system, such as the premium plan or Taylor's differential system, good-will between employer and employee, and stability of employment for the workman, accompanied by a desire in him to better his condition.

3. The most economical way to remove stock can be ascertained only from daily experience. There seems to be some doubt as to whether high-speed steel pays on brass, and a few manufacturers even hesitate to use it on cast iron. There is also some doubt as to whether it pays on finishing cuts, but the consensus of opinion is that it does. At any rate some manufacturers have wasted much money by using high-speed steel too extensively. As one expert on this subject said, they have gone "high-speed crazy." Other manufacturers have been too conservative in their use of this steel, and have therefore lost money by not taking advantage of the opportunities of increased production. There is only one way to determine how far to use it, and in the next issue of this Magazine a plan for doing this will be proposed and developed, with reproduction of the requisite forms and record systems.

THE PAST AND PRESENT OF THE MINES OF MEXICO.

By G. C. Cunningham.

The author of this article is resident in Mexico, and in close touch with practical mining work in that country. The text has been submitted to a well-known mining engineer whose practice makes him intimately familiar with conditions in Mexico, and it has his full endorsement. It is presented on the authority of these two excellent sponsors.—The Editors.

MEXICO has for so many years been a land of romance that, to this day, one is in certain circles reluctant to speak of things Mexican, for fear of not being believed. For instance, some months ago I was crossing on a Pennsylvania ferry-boat with a group of typical New York business men, who were discussing with much incredulity newly read newspaper reports about Pedro Alvarado, the Mexican millionaire—he who was in one day transformed from a poor laborer into one of the richest men south of the Rio Grande. It happened that I knew Alvarado—knew that the reports about him were perfectly true; moreover, having lived for half a life-time in the Republic of Mexico, I was interested to hear what these men had to say on the subject. They were all prominent, well-known New Yorkers; one was a big importer; two, bankers of renown; another was a lawyer of international repute, and the last a street-railway man. None of them, it appeared, had ever been to Mexico, but they nevertheless spoke their opinion of the country, its resources and its future, etc., and the consensus of their united opinion was:

"It is all rot; you can hear pretty nearly any fabulous tale about these Mexican mines, and it is dollars to doughnuts that none of them ever paid a dividend."

The oldest man of the group (who, it appeared, had large copper interests in the Lake Superior regions) nodded his head. "You are right, gentlemen," was his verdict. "I'd like to see a list of Mexican mines that pay, or ever did pay, a dividend."

Having thus damned the mines of Mexico, these men proceeded to discuss, first, the absolute surety of revolutions in Mexico upon the death or retirement of Diaz; second, the trouble that was bound to occur when Mexico changed from a silver to a gold currency basis.

I listened breathlessly, and was genuinely grieved when the ferry-boat bumped into her slip; there is nothing more amusing than to hear men who really know something make statements such as these gentlemen advanced with such assurance.

It is for the benefit of men such as these, as well as for the enlightening of other Americans who have no correct idea of the sort of country they have to the south of them, that this article is written. The statistics and figures that it will set forth are absolutely correct, having been checked with Government and private reports, and with the City of Mexico *Boletin,* for which reason the figures given can be absolutely relied upon.

No one can tell when mining really started in Mexico. When the Spaniards came here in the year 1520 or thereabouts they found a great deal of gold, silver, copper, besides other minor metals and precious stones. Many mines were then being worked in a fashion by the natives, and many of these mines were ingeniously hidden by them from the Spaniards—so ingeniously that they have not all been located, even to this day. Numbers of Indians were tortured, in the effort to make them disclose the whereabouts of such mines. Some of the Indians weakened and told, but others did not.

When the conquest of Mexico was finally accomplished, the conquerors inaugurated the Spanish mining era in Mexico—which has since been superseded by the American. Driven by Spanish taskmasters, the natives of Mexico were forced to locate mines, and then labor in them. In the mining system of those days the question of "expense" was entirely eliminated; the slaves had to work for nothing; if they would not work, the Spaniards flogged them to death. Under this somewhat strenuous method of dealing, some of the greatest mining camps in the world were located—opened up, so to speak—and gophered to their fullest extent. During the period lasting from 1550 to 1700 most of the great Mexican mining camps were located; many others, however, were so far from the sort of communication provided in those railroad-less days that they were little explored. But at this time the camps of Real del Monte, Taxco, Guanajuato, Zacatecas, Catorce, San Dimas and others were uncovered.

During this period some burro drivers accidentally discovered a mine in Guanajuato. This old mining camp—now pretty well worked out—produced within the next two or three hundred years over $1,000,000,000 in silver and gold, of which the Conde de Valenciana (originally a poor prospector) acquired $100,000,000. The records of "La Valenciana" still exist in Guanajuato and the City of Mexico.

In Taxco, down in the more remote State of Guerrero, a wandering, "good-for-nothing" Frenchman, by the name of Borda, found some mines. Rather, they were prospects; he made them into mines. They produced in round numbers something like $40,000,000, and their owner became known as "Señor Don José de la Borda," a man of standing and renown. He it was who built the beautiful gardens in the town of Cuernavaca, afterwards frequented by the Emperor Maximilian and his Empress—nowadays by the American tourist. Borda, with the usual lavishness of the miner the world over, built churches, endowed this institute and the other, and generally threw away his money until finally he died, in abject poverty, with not a cent remaining to tell the tale of the original forty millions! Perhaps, however, he was one of those millionaires of whom we read, whose pervading wish is to die poor.

Another poor man who eventually became a multi-millionaire through Mexican mines was one Pedro Romero de Terreros. Originally he was an insignificant store keeper, but he "struck it rich" to the extent of many millions of dollars. One is glad to record that *he* did not waste his millions in the building of churches, or riotous living; on the contrary, so wisely did he handle himself and his riches that he was created Count of Regla, became the friend of the King of Spain, and was held in honor throughout both Old and New Spain.

During this period Zacatecas gave to the world a total production of $900,000,000 in gold and silver; a little later Real del Monte (the famous English camp about which Charles Dickens wrote in his "Household Words," etc.) contributed the mere bagatelle of $600,000,000. All of these great mining camps were more or less centrally located; that is, in the central-southern part of Mexico. Those of Chihuahua, Sonora and Sinaloa, being very remote, were not explored by the Spaniards to any great extent; in fact, even now they are not well exploited.

In Durango, however, there were some great mines, and the most promising ones were found and opened up, nearly one hundred and fifty years ago, by a Spaniard named Zambrano. He it was who found the mine of "Candelaria," and existing records show that he took out of it over $100,000,000 in gold and silver values.

Most of the Spaniards merely gophered a mine—that is, dug out the richest ore where found, regardless as to whether any pillars were left for supports or not; "after them the deluge" they probably thought. But Zambrano evidently knew something about mining; he stoped and worked systematically, and went on down all the time. He worked the "Candelaria" to a depth of 2,000 feet, and the rock and ore thus dug out went to the surface on the backs of peons. Water, when encountered, was hoisted out in the same manner.

Zambrano, his "pile made," did not suffer his light to be hidden under a bushel. He spent his millions right freely, among other things taking tours abroad in great splendor, building noble mansions, and otherwise using his money to advantage. When he died (which occurred after the finish of the American-Mexican war) he left among other assets the neat little sum of £12,000,000 on deposit in the Bank of England. So exit Zambrano, last of the Spanish miners—peace to their ashes! This brings us down to the present century; and, in view of the above statistics of wealth taken out of Mexican mines, it may sound unreal to say that mining in Mexico is only in its infancy. Yet anyone who really knows the country—its past mining records, and what it can do under up-to-date mining methods—will tell you this same thing. For this reason:—

Most of the mining described above was done in the most primitive manner, under ignorant direction, and by ignorant labor. At that time there were no methods of treatment beyond the patio process—a crude and lumbering one, at best. Therefore it paid only to gopher out such ores as carried undoubted high values, and either did not have to be treated at all, or in that event could be patiod. For this reason ores that carried a value of, say, 5 kilos (150 ounces), would be taken out, and anything less would be left in the mine, or thrown away on the dump, being worthless from their point of view. And as they dug out this rich ore as they found it, doing no timbering and leaving no pillars of ore to act as supports, naturally the mine would sooner or later cave in on them, and they would have to abandon it, even though it was really only scratched on the surface, and enormous values lay underneath their gopherings. Therefore, when you hear of a rich mine, "first worked, and abandoned by the Spaniards," do not condemn it as obviously a fairy tale, and say "If it was so good, *why* did the Spaniards abandon it?" For there are many such mines in Mexico, in South America, and wherever else the Spanish miner left his trail.

Under the present-day method of mining and ore-treating, ore carrying only 1 kilo in value is often bonanza, according to its distance from railways, local smelter rates, etc. So that the abandoned ore on the dumps of these old Spanish mines, and the refuse that they left behind them, can be handled to immense value when one uses the modern American methods.

Coming down to present days and figures—which always speak louder than words—some of the Mexican mines are paying regular monthly dividends as stated below, the dividends quoted being for the month of January, 1904.

Companies.	*Per share.*	*Total paid.*
San Rafael	$48	$57,600.00
Peñoles	40	100,000.00
Norias de Bajan	30	30,000.00
San Rafael (2nd)	24	28,800.00
Soledad	20	19,200.00
Dos Estrellas	10	30,000.00
Natividad, Oaxaca	10	24,000.00
Real del Monte	10	25,540.00
Sorpresa	10	9,600.00
La Blanca	5	62,500.00
Sta. Maria de la Paz	5	48,000.00
Victoria, San Luis Potosí	5	12,500.00
San Carlos, Zacatecas	5	12,500.00
Esmeralda, San Luis Potosí	5	12,000.00
La Union, Reduction Works	4	12,000.00
Santa Gertrudis, Guadalupe	3	180,000.00
B. de Medina, Reduction Works	3	6,000.00
Turquesa, pfd. stock	3	750.00
Total of dividends paid		$670,990.00

This list is taken from the regular monthly notice, which is issued every month in the City of Mexico. It is taken at random, and is given merely to show what just a few of the Mexican mines are doing, for the list in question includes merely a few of the centrally located mines, and does not mention the great number of mines that are located in the most populous mining districts For instance, the great mines of Chihuahua and Sonora are not spoken of. I believe that even the incredulous gentleman who had copper stocks, and who wanted to *see* a "list of Mexican dividend-paying mines," would think the above random showing no poor one.

Included in the above list, however, are the famous mines of "Natividad," Oaxaca; "Peñoles," Mapimi, and "Dos Estrellas," of El Oro.

The "Natividad," English-owned, yields in a six-days run of its mills 15,674 ounces of silver and 489 ounces of gold. The mine has for years paid a regular monthly dividend of $6 per share, and the stock consists of 2,400 shares, which are quoted now at $1,000 each, par being $30. Anyone can readily estimate what percentage is made on this investment, and no one will wonder that "Natividad" stock cannot be bought.

The "Peñoles" of Mapimi is German-owned; and while information regarding this mine is not easily secured by the public, still it is known that millions of dollars were spent on it before any values were taken out. Then the company went to work mining good paying ore; they have been doing this ever since, with the result that their monthly dividends amount to $100,000, and their shares are now quoted at $4,000 each, with none offered on the market. This mine has enormous values blocked out for future work, and their manager gets in salary about the same sum that President Diaz is paid for directing the affairs of the Republic.

These are only samples; with time, and sufficient room, one could give descriptions of a great number of Mexican mines that are today busily hoisting out ton after ton of pay-ore, and paying regular dividends. But these data would fill a book.

There is the "Dos Estrellas" mine, for example—considered by experts as one of the best gold mines on the Western Continent. And one would also like to tell at length of a Danish sailor named Sahlberg, who "laid off" on one of his trips to a Mexican port, and prospected a little in the El Oro camp. There he denounced a prospect which later became the great "Esperanza" mine. It made its fortunate owner a multi-millionaire.

None of these mines is in the north-western region of Mexico, wherein most experts agree that the coming mining territory of Mexico will exist. This of course includes the States of Chihuahua and Durango, while Sonora is a magnificent district. In fact, more American mining capital is invested in Sonora than in any other State of Mexico, while Chihuahua follows close behind.

Probably the most favorable feature about mining in these north-western States is the amount of gold that is being discovered, as prospecting and development approaches the Sierra Madres. In the State of Chihuahua there are now producing gold mines which have only just been opened up, but which are making splendid showings already. The famous "Lluvia de Oro" gold mine, not a very great distance from Parral, Chihuahua, is already spoken of as "one of the world's great gold mines"; while the "Adela," located within a three hour's ride of Parral, is a very fine mine.

Because of her silver standard, Mexico is generally spoken of as a silver-producing country. Not altogether without reason, for she has produced, up to date, nearly *four billions* worth of silver. Even so, however, her gold output has lately increased most notably, having made a twelve-fold increase within the last twenty-five years.

For 1890-1891 her gold output was $920,702; for 1901-1902 it was $9,928,386.28, while for the fiscal year of 1902-1903 it had increased to $14,805,975.27.

Mexico's silver output for 1902-1903, by the way, was $82,320,735.32, while copper was $18,353,943. As a copper producer, Mexico now ranks second, being exceeded by only the United States.

Proven, however, that Mexico has dividend-paying mines, there are still people like the gentleman of the ferry-boat; while willing to invest in Lake Superior copper—Schwab "Ship Trust"—and other such investments, they nevertheless fear to put money into Mexico, for fear, first, of revolutions; and, second, of the troubles that will ensue when the money basis is changed from silver to gold.

So far as revolutions in Mexico are concerned, it is not necessary to say anything more than to point out the fact that the United States has over $500,000,000 invested in Mexico, half of which has been invested here within the last five years. Americans control all of the great railways, particularly those from the border; they control the smelter trust, the greatest mines, the manufacturing enterprises, the electric-power plants, and even the street railways. Americans swarm from one end of the Republic to the other; there is hardly a mining camp, a station eating-house, a desert-place, even, where one or more Americans will not be found. There is hardly a Mexican town where one cannot hear the familiar vernacular of the United States.

These things being so, does the most ignorant politician believe for a moment that in the remote event of trouble in Mexico upon the death or retirement of Diaz, any trouble or molestation would be visited upon the Americans in Mexico? Not for a moment; what the Mexicans thoroughly believe in their hearts (particularly since this Panama matter occurred) is that the United States is simply *aching* for a chance to get her claws on Mexico! The great officials believe it; the lower classes, and even the peon workmen have this idea. From personal experience and knowledge, I believe that *no slightest chance will ever be given the United States to retaliate, in any manner whatever, for offences to United States citizens, or their property, in the Republic of Mexico.*

As for monetary reform:—there is no doubt that within the next few years Mexico will change from silver to gold, or else arrange a certain fixed price of silver. But one fails to see wherein anyone will suffer loss thereby; it has not been the experience of the many countries that have changed their monetary systems.

THE INDUSTRIAL VALUE OF MANUAL TRAINING.

By Frank T. Carlton.

The series of articles recently published in this Magazine dealing with the apprenticeship question (December, 1903, to June, 1904) have considered almost altogether the maintenance of the supply of future industrial *materiel* by institutions existing within the shop. Mr. Carlton goes back to the training of the boy before he has reached the age of apprenticeship, and discusses what can be done, under modern conditions, to make the school supply that simple but very important skill in handicraft which in more primitive society the boy gained by the "chores" at home.—The Editors.

AS the years pass by, industrial and social institutions suffer constant change; the relative importance and value of this function of one increases, while that function of another decreases. A readjustment is necessary in order to meet the new situation satisfactorily. Progress is change—growth on the one hand, decay on the other. New functions and duties devolve upon some institutions; other functions are gradually transferred from one to another. New inventions, methods of rapid transportation, increased trade, the growth of cities, change radically the relations existing between the home, the factory and the school. With the rise of the modern factory system, the decay of the old forms of apprenticeship, and the introduction of an extreme and minute division of labor, conditions in the industrial world were revolutionized. The home and the factory are now sharply differentiated; the factory assumes many of the functions formerly belonging to the home. The latter, particularly when situated in the city, offers very little opportunity for observation of, or participation in, constructive work of any kind. The home chores are few; there is no wood to split, no garden to hoe, no cow to milk, no blacksmithing is done, no shoes are made, no cloth is spun, and no wagon or sled is built; all this work is performed elsewhere. In fact, the city home provides no regular and systematic work of importance for the youth.

The work in our shops has become so specialized that a boy from the time of his entrance is forced into a rigid and monotonous routine, usually tending automatic or semi-automatic machines. He is able to observe or learn little beyond the few simple operations required of him. As a consequence he soon gets into a rut, and is unable to change readily to another kind of work, except that involving little skill. It is this unreasoning, uncomprehending boy who becomes the inefficient and unreliable workman. Apprentices are given better opportunities, it is true; but a few only of the larger engineering establishments receive apprentices, and in those their number is necessarily limited.

The value of the home and the shop as factors in the training of future workmen, foremen, and engineers has greatly decreased as a result of the changes just mentioned. As this function of these two important institutions atrophies, the school is obliged to take upon itself new obligations; its sphere of action and influence is enlarged to meet the new situation. The technical school, the manual-training high school, and ward-school manual training, have been grafted on to our educational system to meet the demand for boys who possess trained hands and eyes—boys who are able to plan and to execute—boys who are industrious and not afraid of overalls and jumpers—boys who have to a high degree the power of applying knowledge to industrial operations. The value of a good home in the building of character is not minimized or called into question. But the changed environment in and about the home, its complete isolation from productive industry, cooking excepted, has caused it to lose its leading position as a factor in industrial training.

The future of manufacture depends largely upon the new human material which is supplied to the shop and factory. Brains, the ability to do, not stores of unassimilated and unapplicable knowledge, is the great need and demand of today in the machine shop and the foundry as well as in the counting house and the Congressional chamber. The school must be looked to in the future to fill this standing order for trained, resourceful men.

A line of demarkation must be carefully drawn between the trade and the manual-training school. Both are important; both have a legitimate place; but the aims and ends of each are different. The trade school turns its energies toward fitting the student for some particular trade. The manual-training school, on the other hand, attempts to give a more general training. The latter does not aim to make carpenters, blacksmiths or mechanical draftsmen; but it does strive to give the student a first-hand knowledge of industrial operations and processes. The trade school ought to complete the school training of a skilled worker who has taken the manual-training work which should be given in the public schools. The trade school is to the skilled artisan what the technical school is to the engineer. The manual-training school is designed to be a preparation for either.

Manual training aids particularly the two classes of workers in the industrial field: first, the young men who are fitted for, and able to take, advanced technical work; second, those who must go directly from the grammar or the high school into the shop, or in some cases into the trade school.

The latter class must not be overlooked or neglected as unimportant. It is unfortunate that our school curricula are drawn up primarily to benefit the small percentage who go to college or technical school; secondary consideration only is granted the larger number who go directly into their life work. The future progress and prosperity of the country is as dependent upon a trained rank and file in the shops as upon the superior character and training of our superintendents and engineers. The value of higher technical training is dependent upon the efficiency of the preparatory work in a two-fold manner. The quality of the work done by a student in the technical school is materially affected by the kind of training which he has previously received in the preparatory schools; and the best engineer needs competent workmen in order to carry his projects to a successful issue. Our technical schools might be the best in the world; their graduates might be the very skilful engineers, chemists, superintendents and designers; and yet if the workmen who are to be directed by these men are inefficient and unskilful the results of their combined efforts would not be encouraging. Our industrial system would be top-heavy.

The boy who goes into the shop in his early youth must be taught neatness and accuracy; and he should understand the elementary principles of wood and metal working, mechanical drawing, algebra, geometry, and have a fair command of the English language. If the boy can be kept in school until the end of his sixteenth year, this amount of training can be given him. The last two years of this course, which are the first and second years of the average manual-training high-school course, are extremely important. I believe that the value of this work is often underestimated. Technical education was introduced before manual training, and when the latter was first recognized it found a place only in the high school. Gradually, grade by grade, it has crept down toward the kindergarten until, in a few American cities, manual training is found in each of the twelve grades. The universal introduction of such work into the public-school system should be demanded by clear-sighted employers and labor leaders; but, in order that the young men may reap the benefits, the school age must also be raised. If the employer and employee will unite on this proposition, it will mean much in the future. The interests of both are certainly harmonious in this instance. A well-trained class of workers means the maintainance of industrial supremacy, and the greater likelihood of peaceful relations between employer and employee. Ignorant, inefficient, and "sweated" laborers are a menace to industrial growth and development.

The large number of students, living in all sections of the United States, who are taking work in correspondence schools, in public, private or Y. M. C. A. night schools, testifies to the great demand for elementary technical education and manual training. Many of these persons left school at an early age because they were unable to receive instruction of this character. School teachers are as a rule very conservative. They are too often far removed from the practical affairs of life, and few of them have received such an education as will make them appreciate the need of industrial and manual training. This movement toward greater emphasis on industrial education must be accelerated by those actively engaged in industrial pursuits. The latter should be keenly appreciative of the need of well-prepared timber for the future industrial edifice.

Turning our attention to the other boy, the future technical-school student, the question immediately arises: What preparation does he require? It may be safely assumed, with little fear of controversy, that intellectual training alone does not properly fit any boy, especially one who is to be engaged in engineering pursuits, for the active duties of life. It is extremely desirable, if not absolutely necessary, that the youth who is to be the future engineer, superintendent, foreman, or manager should receive a careful training of eye and hand, and that he should be brought into direct and personal contact with materials and machinery before he enters the technical school at the age of eighteen or nineteen. This experience can be given him in the public schools. The preliminary work for the engineer need not be differentiated from that given the skilled workmen. Both classes should receive the same instruction.

If this instruction were given in all or a majority of city and village schools, the manual-training high school would relieve the technical school of the necessity of teaching joinery, wood turning, elementary pattern making, forging, elementary machine-shop work, and much of the simpler work in mechanical drawing. In drawing, for example, the graduate of the manual-training high school should understand orthographic and isometric projection, perspective, tracing, and blue printing. He should be able to execute neat, accurate, and well lettered working drawings of existing machines; but he should not be expected to design such machines.

Manual and mental training must ever proceed hand in hand; the one is not complete without the other. Exactly as the arithmetic, the algebra, and the geometry taught in the high school are preparatory to the work in higher mathematics of the technical school, should the shop work and drawing be equally preparatory to laboratory work and machine design. The present duplication of equipment and consequent waste of energy can be avoided. The technical school has its own definite and urgent problems to solve; it ought not be asked to maintain this preparatory work which should be given to all who enter industrial pursuits, workmen as well as engineers.

The American workman is intelligent and resourceful; as a consequence he is a very efficient man. The United States, thanks to its material resources and the sturdy character of its inhabitants, has forced itself into the front ranks of industrial nations. Shall it continue in this desirable position? It has cherished one institution which, if properly utilized, will enable an affirmative answer to be returned to this question. This is the American public-school system. By means of its effort the present high grade of intelligence and efficiency can be maintained; but its future ideal must be to find the proper work for each of its students. The school must say emphatically that a first-class machinist, a good fireman, or an excellent carpenter, is to be preferred to a second-rate lawyer, physician, minister, or teacher. The necessity for primary, grammar, and secondary manual training is great. The schools have too long given a major portion of their time and energy to a training which was particularly beneficial to the professional man. The foundation of industrial education should be laid strong and well; good work in ward and high schools is essential to future progress in the arts and sciences.

A careful study ought to be made as to the extent and character of the industrial work which might profitably be introduced into the public-school system; manual training, particularly in the ward schools, is still in an unsettled and experimental stage. The methods employed and the extent and character of the work given are by no means uniform. The employer and the employee as well as the educator must consider this question; out of the conflict of opinion good will come. Let it ever be remembered that competent men are needed in all grades of industrial work, and that the public school should render valuable service in supplying this demand.

THE MINES AND MINERAL INDUSTRIES OF ITALY.

By Enrico Bignami.

Signor Bignami's descriptive account of the lead and zinc mines of Sardinia will be followed later by a similar review of the sulphur production of Sicily, thus covering the most important mineral industries of Italy.—THE EDITORS.

SINCE the time of its political unification, Italy has been divided into nine mining districts, of which the most important is that of Iglesias, including all of Sardinia. Its production represents half of that of the entire kingdom, exclusive of the production of sulphur, which is obtained almost entirely from Sicily. In 1902, for instance, while the metallic products of all the mines of Italy had the value of about 50,00,000 lire, those of Sardinia contributed about 25,000,000 lire to that total.

Of the two provinces into which Sardinia is divided, Sassari and Cagliari, the latter is the richest in metallic minerals. From the most ancient times this richness has attracted the attention of scientists and promoters. The first works go back to the Phoenicians. In the period which followed, the Carthaginians and the Romans* applied themselves also to the mines; but after the fall of the Western Empire the art of mining fell into oblivion throughout the island until the eleventh century. At that time the works were taken up again by the Pisans and the Genoans until the fourteenth century, and then again by the Arragonese, only to be abandoned again upon the discovery of America. After that time it may be said that the mines had been left in almost complete oblivion, and that it was only upon the annexation of Sardinia to the kingdom of Piedmont that they began to revive.

In the province of Cagliari lead and zinc mines have the preponderance; the same may be said of Sassari, but as compared with Cagliari, its mines are in the ratio of 1 to 14. For both provinces however, the fact is noteworthy that, while in other well-known mining centers the production is restricted to a single kind of metallic ores, in Sardinia almost all metallic ores occur in quantities more or less large; some, like lead, silver, and zinc, in very remunerative veins; others, like iron, manganese, antimony, copper, nickel, and cobalt, in smaller quantities, but still commercially workable; still others, finally, among the immense variety of mineral species associated regularly or perhaps accidentally with the predominant minerals or rocks, are of no industrial value, but nevertheless interest scientists who find in them an endless field of mineralogical, crystallographical, spectroscopic, and geological researches.

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* After having successfully contested with Carthage for the dominion of Sardinia, Rome took not only its immense agricultural wealth, but also its mines. The work was carried on by slaves and convicts, by sinking devious and altogether irregular shafts to depths of 100 metres or more from the surface. The Punic and Roman coins in earthen vases and the lamps which are found leave no doubt about the antiquity of these works; also the discovery of large deposits of lead waste, and of some ingots of lead with Roman mark, proves the existence of important foundries.

Mineral fuels are present also; the beds of lignite and of anthracite are of considerable importance, especially as the principal ones are situated in exactly the region where they are needed for industrial purposes.

Although, as said, the metallic wealth occurs throughout the whole surface of the island, and new fields are opening everywhere to the discovery of various kinds of minerals, it is chiefly in three regions of great importance that the mining has risen to the proportions of an industry of the first order—Iglesiente, Nurra, and Sarrabus. In the first two, ores of lead, more or less argentiferous, hold the field; in the last, those of silver and antimony and the so-called mixed ores, that is to say, those composed of sulphides of lead, zinc, and copper.

The decline in price of silver and the difficulties of treatment of the mixed ores at the present time have greatly reduced the activity of development of the mines of Sarrabus, which once had a period of exceptional prosperity; while the lead and zinc mines of Iglesiente, and the very important and almost isolated silver mines of Nurra, are in a condition of considerable prosperity. In Iglesiente the metalliferous region may be divided into two zones, characterized, in a way, by the two mines which we are about to describe in detail, in the hope of giving a definite idea of the progress made by Italy in the art of mining—the mines of Montevecchio at the north of Iglesiente, and that of Monteponi, farther south.

Montevecchio.—The mines of Montevecchio are in the townships of Guspini and Arbus (district of Iglesias), but a few miles from the seacoast of the southwestern part of the island of Sardinia, and extend for about eight kilometres in an east and west direction, taking in a series of hills which frequently attain a height of 600 metres or more above the level of the sea. They may be reached by a good wagon road, and from the station of Sangavino Monreale by the railroad which belongs to the mines. At the two terminals of the line are large stations with buildings for lodging employees, very large roofed storehouses, and immense storage yards.

While very evident traces of ancient workings dating back to Roman times and even earlier are observed in the numerous mines of Sardinia, in the mine of Montevecchio ancient excavations of any importance are entirely lacking. Nevertheless it can not be affirmed that the great wealth of its veins entirely escaped the notice of the ancient miners. In fact, in old excavations, in the concessions of Seiria and Piccalinna, have been found amphora, funeral urns, earthenware lamps of the Roman period, and copper cups, as well as a mining pump of great archeological interest, together with other objects of the use of which we are not yet certain; and in the museum at Cagliari is preserved an ancient lump of lead found at Carcinadas, bearing the inscribed words: "Imperator Caesar Hadrianus Augustus."

When gunpowder was discovered and came into use in mines, even the harder veins began to be worked, and it may be supposed that under Eléonore d'Alborea those of Montevecchio were worked a little, especially as she had founded a mint at Oristano. The first concession of which modern history makes mention is that granted to a man by the name of Squirro; after it, others are met with; but that upon which the real industry is founded was granted in 1845 by the king Charles Albert to Monsieur Antonio Senna of Sassari, in perpetuity. For the exploitation of this concession and two others, the Société de Montevecchio was founded. Later it acquired two new concessions, those of Seiria and Piccalinna (page 937) and thus came to possess five large adjoining concessions, extending over 2,000 hectares of land altogether, and containing seven kilometres of veins, which really produce about one-third of the lead ore derived from Sardinia.

In the northern part of Iglesiente, directly north of the massive granite of Arbus, where a schist formation is found covered with great tertiary deposits near Arcuentu, the out-croppings of the vein of Montevecchio rise majestically. The vein runs in a northeast and southwest direction, at a nearly constant dip of 60 or 70 degrees. The thickness of the vein is very remarkable, so that it may be considered one of the most important of Europe; at some points it reaches 50 metres. In reality, however, the vein of Montevecchio is not a single one; it is composed of a system of three distinct, nearly parallel veins. The lengths of the three veins are not equal; all three begin at the east, but the chief one does not reach beyond the limits of the first concession, while the other two extend much farther to the west, and both cross the western concessions.

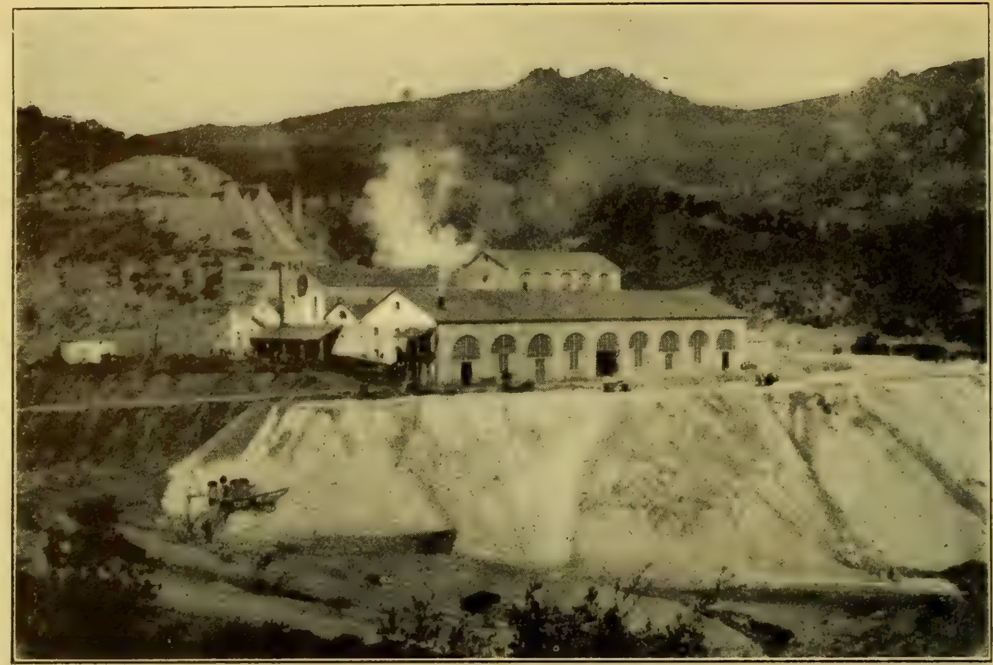
From the two larger veins in the first (eastern) concession, two branches separate, turning a little to the south, but they are not of very great importance. On the other hand, at the south of this group of veins, that is to say in the direction of the massive granite of Arbus, there are three more veins running in a direction perpendicular to the first. Dikes of eurite, well worth the trouble of excavating, run parallel to these latter. This collection of veins forms therefore a great deposit divided in two directions perpendicular to each other; it probably forms a single system, due essentially to a dynamic phenomenon. The veins of Montevecchio have a matrix of quartz; in the principal vein the quartz is compact, in the secondary vein it is friable at various points, and in the third vein it is rich in pyrites. In the outcroppings of the second vein, however, considerable quantities of barite and siderite occur with the quartz.

The mining operations are distributed over the principal vein and the secondary one. The ore is galena, accompanied in some places with blende. It tends to an arrangement in large masses or in layers situated almost vertically in the vein. The columnar masses of Colombi, S. Baroara, and the masses of so-called "N. 8." are celebrated above all; they have furnished for several years almost the entire production of the first concession. The galena of Montevecchio is argentiferous, as are all the Sardinian galenas, to a greater or less extent. The silver content varies from 1,000 to 250 grammes per ton of ore; it diminishes in going from east to west, so that the ores which contain the greatest amount of silver are found in the concession of Piccalinna. The lead in the ores of Montevecchio varies from 60 to 70 per cent. The occurrence of the galena in the veins varies in the different excavations. In some places the vein appears irregularly bordered with beautiful bands of galena, siderite, or pyrites, more or less large, and separated by quartz; while in other places breaks are found filled with pure galena in fragments with sharp angles, cemented together by quartz and siderite. In still other places, finally, traces of copper occur, and secondary formations of calamine. The Montevecchio formation is very interesting also from the mineralogical point of view, and it is deservedly well known by museums on account of its magnificent cerusites of silky lustre and its anglesites of superb emerald-green color. Conspicuous outcroppings of the principal vein, and very imposing ones from the secondary veins, rise in the range of hills that separate Montevecchio from Guspini and Arbus. Towards the north, on the other hand, the truncated summits of the trachytic hills rise imposingly, among which occurs the outcropping so characteristic of Arcuentu; they are crossed here and there by euritic dikes, which are recognized easily by the regularity of their course.

THE MONTEVECCHIO MINES; PICCALINNA CONCESSION.

The concentration plant of Sanna, built in 1865, has undergone several changes, of which the last was intended to double its capacity and provide it with a special department for the treatment of blendes. The power is furnished by a 120-horse-power gas engine, which drives the different sections by means of friction clutches. A little gas-producing installation, provided with a purifier, produces the gas for the engine. The principal shaft, Sanna, is a short distance from the concentration works; it is the center of extraction of the second concession, situated at an elevation of about 262 metres. The surface works, like those of the third concession, have a two-cylinder hoisting engine in the upper story, which drives the shaft of the hoisting drums by gearing. A horizontal engine, also acting through gearing, drives the system of piston pumps, which lifts the water from the mine shaft. In the lower story are placed the boilers.

The ore undergoes a preliminary treatment for the purpose of separating the richest part, or that easiest to melt, which it would be a mistake to send to the concentration plant below; and also the poor



"PRINCE TOMMASO" CONCENTRATION PLANT, MONTEVECCHIO.

ore, which it is better to sort out as much as possible, so as to avoid the cost of subsequent treatment. This double operation is accomplished by dividing the material which comes out into three classes—fine, medium and coarse; the fine is concentrated by means of English scrubbers, the medium is carefully hand sorted, and finally the coarse is broken up with hammers, and the rich ore picked out from it by hand. For a large part of this work, which is carried on partly out of doors and partly under sheds, female and child labor is employed.

A cross road leads from Colombi to the shaft of S. Antonio nearby, which is provided with a fine hoisting engine and a well-managed installation of piston pumps. The depth of the shaft is 165 metres, and it serves for the extraction of ore from four different levels. To get an idea of the character of the works below ground, it is necessary to visit the regions of excavation by going down in the cages as far as to level of Ignazia, passing through a part of that gallery, descending again through the works to the level of Enedina, and returning from there to the shaft to ascend to the surface. At S. Antonio the material is subjected to the same operations as those at Sanna just described, except that the rock is very much harder and immensely more difficult to break with hammers, so that it has been necessary to substitute for them very heavy crushers of the Marsden type. The partly concentrated material from which the rich and the poor ore has been separated is sent to a concentration plant called "Prince Tommaso"; views of the exterior and interior of these works are shown on this page and the page opposite. Near to it a new installation has been built for generating, by means of gas engines of the Letombe type, the electrical energy necessary for various purposes, and for electric lighting by the three-phase system.

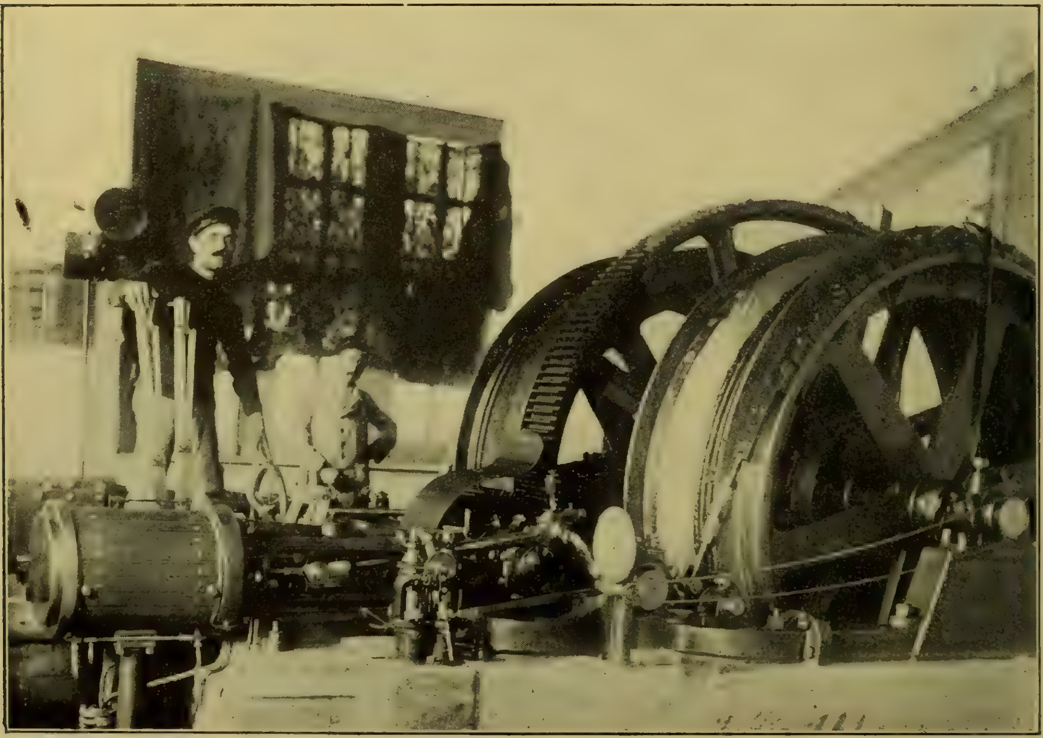
Upon entering the concentration works, the roll crushers are first met; then the revolving sieves or trommels, which classify the crushed material according to size of the pieces; and finally the mechanical sieves or riddles for gravity concentration. The highest of the concentrates are very rich and easy to treat in the smelter; the leanest of the waste is poor enough to be thrown out; there is, however, a proportion of partial concentrates, which must be returned to pass through the concentrator again; before this second treatment, however, the material is passed through a battery of thirty stamps instead of through the roll crushers. Revolving tables are used for the treatment of the slimes.

Nearby is the concession of Piccalinna, with its principal shaft at a height of about 230 metres. Its hoisting engine, shown on page 940, is worthy of mention. The ores or hand concentrates taken from

INTERIOR OF THE "PRINCE TOMMASO" CONCENTRATING WORKS, MONTEVECCHIO.

that concession are carried up on a little inclined plane to the concentration works, "Prince Tommaso."

Mine of Monteponi.—The mine of Monteponi (see illustration on page opposite) is situated 2.5 kilometres west of the town of Iglesias, upon a mountain of the same name overlooking the valley of Iglesias to the sea. It is connected to the town by the national road of Porto Botte, and by a branch of the railroad in continuation of the line, Cagliari-Iglesias. Half way up the southern slope the principal installations of the mine are grouped, forming an extensive industrial establishment, at which the tracks and railroads coming from all parts of the mine terminate. In the middle of this group of works are the mouths of the two principal shafts for extraction of ore and raising of water. A cable railroad with a slope of 33 per cent., covering a difference of level of 100 metres, connects the works with the railroad station and transports the cars as they come in or go out.



HOISTING ENGINE AT THE PICCALINNA CONCESSION, MINES OF MONTEVECCHIO.

The first authentic records of mining operations at Monteponi are given by the will of the feudal baron by the name of Berto de Santo Miniato, dated Dec. 3, 1324, in which mention is made of the excavation or mine "La Comunata" in Monte Paone. The first regular gallery was opened by Pierre Diana of Iglesias in 1744, and is called San Vittorio. It is at a height of 270 metres, and is now used for the condensation of the fumes of the lead foundry. The Monteponi Company, which has its real headquarters at Turin, with Italian capital, was formed at Genoa on the 18th of June, 1850.

The ores of the mine are closely associated with dolomite and with lias, which is distributed sporadically at the surface in the dolomite. The ores which are worked are those of lead (galena, cerusite), and those of zinc (calamine and smithsonite), besides a little iron ore (limonite) used as flux for the lead. Galena preponderates at the southern part of the mine. The calamine tends to concentration towards the summit of the mountain, north of the lead-bearing region. On the sides of the mountains other secondary mining lodes are found.

INCLINED PLANE, MONTEPONI MINES.

The present production of the mines and the foundry at Monteponi is:—Lead ores about 6,000 tons, zinc ores about 14,000 tons, metallic lead about 4,000 tons, and metallic silver about 4,000 kilogrammes.

In the half-century between the foundation of the Monteponi Company and June 30, 1900, the total production has been:—Lead ores 319,882 tons, calamine (raw) 14,485 tons, calamine (calcined) 340,657 tons and zinc ores 355,142 tons, a total of 675,024 tons.

The annual mean has therefore been less than the present production, especially for the zinc ores. The total of the productions of

BOATS CARRYING THE PRODUCTS OF THE MONTEPONI MINE TO CARLOFORTE, FOR RESHIPMENT TO THE MAINLAND.

lead and zinc obtained from the mine is the result of a very extensive net-work of underground works, which have explored and worked the lode at numerous levels from the top of the mountain (358 metres above the level of the sea) down to the subterranean level of 15 metres above the sea. It is computed that altogether the works have about 80 kilometres of galleries, some being double.

The Monteponi Company at present employs about 1,600 persons, including laborers and administrative or supervising officers. The mine of Monteponi alone employs 1,100 laborers, while 400 more are distributed on the Monteponi-Porte Vesme railroad, in the lignite mines, and in two lead mines and two zinc mines of less importance than that of Monteponi. The laborers employed at Monteponi are divided as follows:—miners and overseers, 320; drivers and car men, 120; assigned to calcination and sorting, 90; laborers in the wash houses, 260; laborers in the lead and zinc foundries, 140; mechanics in the shops, 70; masons, assistants, watchmen, etc., 80.

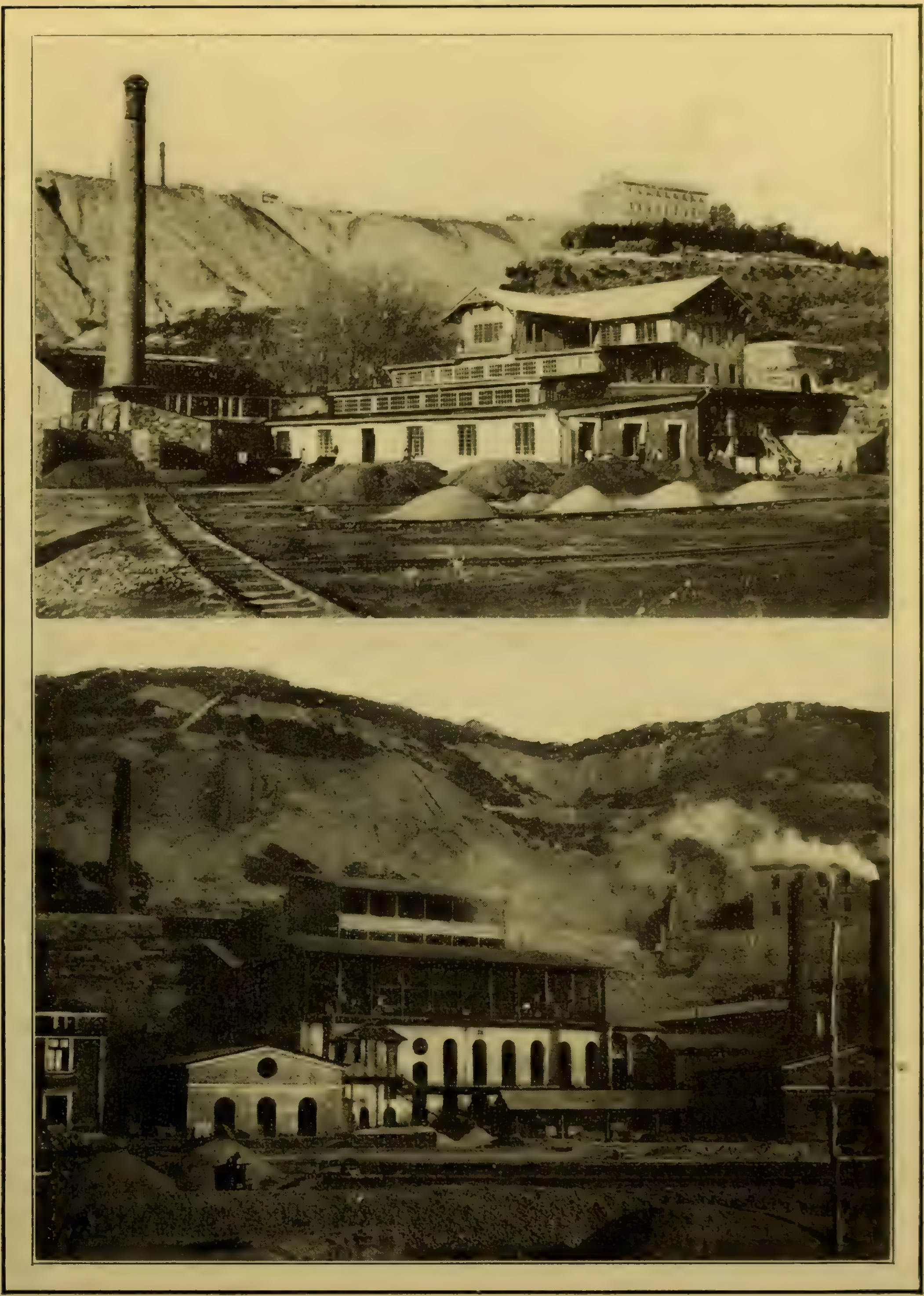
The length of the working day is eight hours inside of the mine, and ten hours and a half outside of it, and in the ore-dressing establishments and shops. The labor inside is mostly done by piece work.

The first mine railroads, with iron rails at a gauge of 0.65 metres, and the first hand cranes were introduced by the first director of the mine in 1850. The first machinery for the concentration of poor ores dates from the same period. It consisted of a hydraulic wheel, revolving sieves, so-called "English" hand sieves (jigs), and conical tables (round buddles) for the sands. This embryonic concentration plant was in use till 1876. In 1863 the excavation of the principal shaft for the extraction of ore at the center of the mine was begun, at a height of 206 metres above the sea. Up to that time all the products of the operations had been taken from horizontal galleries. This shaft has now a depth of 211 metres, and six levels branch off from it, of which the lowest is 14 metres above the sea. The shaft has been provided with a 40 horse-power steam hoisting engine, with two cages or two-story hoists and safety appliances. In deepening the shaft the permanent level of water was reached at 70 metres above the sea, and the contest was undertaken with that element, which has not caused any disturbance. The dolomite which forms the greater part of the interior of the mountain, and even the metalliferous rocks of all the mines of the district of Iglesias, is rendered cavernous by the numerous hollows eaten out by solution in atmospheric waters which pass through. After having attempted to cope with the water first of all with hand pumps and pumps worked by horses, and then by small steam pumps, recourse was had in 1869 to a direct-acting steam pump with an internal cylinder diameter of 1.10 metres, and maximum stroke of 3.50 metres. Two sets of force pumps, 0.40 metres in diameter and two of suction pumps 0.30 metres in diameter, distributed along the shaft, completed the installation, which is capable of lifting 1,500 litres per minute and developing 130 horse power. But the insufficience of the pump described had to be admitted very soon, and others were applied so as to lift 21,000 cubic metres of water per day. In May, 1881, the attempt to overcome the waters of the bottom by means of pumps was definitely given up, in the expectation that the drainage tunnel already begun would offer them an outlet to a lower level. This gallery starts from the marshes of Fontanamare, at a height of 2.70 metres, and reaches the metalliferous dolomite at the west of Monteponi at a height of 6 metres, after crossing clayey schists, sandstones and limestones in the valley of Monteponi. It begins as a trench, for a length of 112 metres, and continues underground for 4,190 metres before reaching the dolomite and striking the first flow of water. The metalliferous dolomite was reached on March 8, 1885, and then a flow of water of 32,000 cubic metres per day took place, which lowered the level of the water in the mine from 61.50 to 55 metres above the sea.

In the next year work on this tunnel was resumed, and it was prolonged to 4,252 metres, carrying a daily flow of water of 60,000 cubic metres. Finally, on August 2, 1889, an immense vein of water was opened, and all the works of the mine rapidly became dry. In the first twenty-four hours the flow reached 307,550 cubic metres; afterwards it diminished gradually to its present constant amount of about 110,000 cubic metres per day, or 40,000,000 cubic metres per year, representing the quantity of water annually absorbed by the metalliferous ground situated at the west of Iglesias. The total cost of this work was 1,920,000 lire.

LOADING ORE BOATS, PORTO VESME.

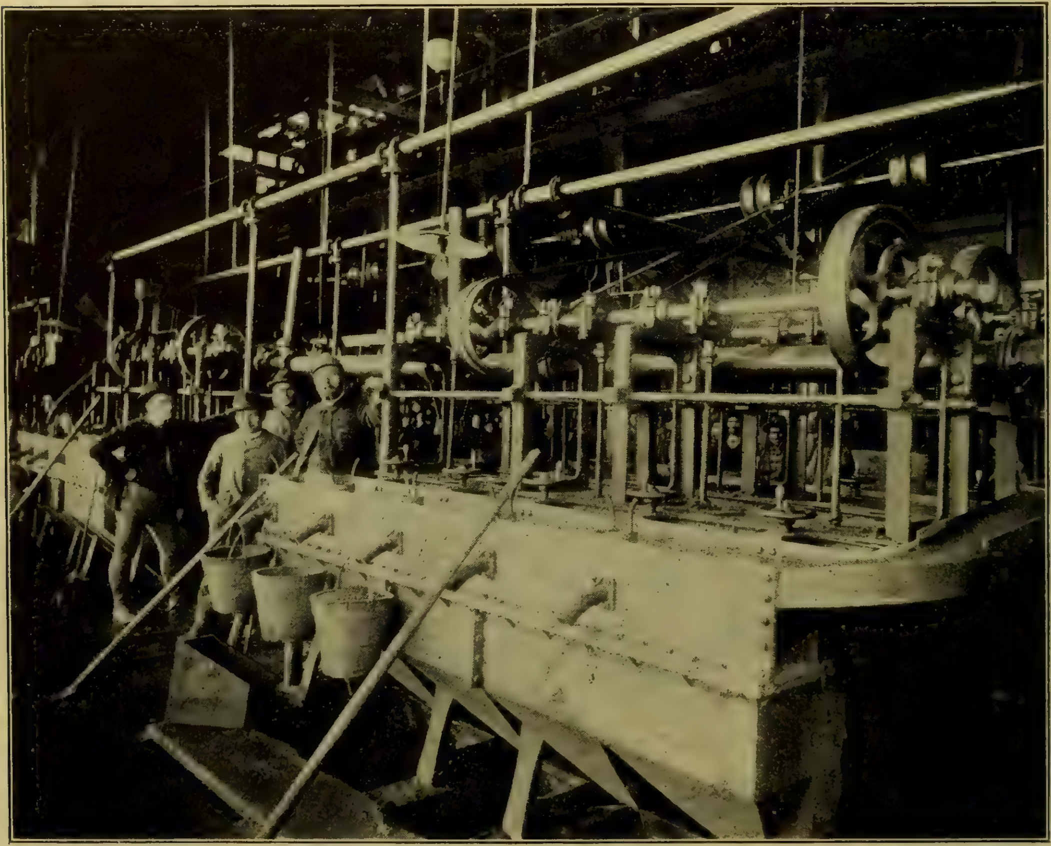
Up to 1870 transportation of the products of the mine was by carts, which carried them to the shore at Fontanamare, a distance of 8 kilometres, and from there by boats to Carloforte (page 942), where they were loaded into ships to be carried to the main land. The company decided very soon, however, to construct a narrow-gauge railroad of its own. The cost of construction of this line and of its equipment amounted altogether to 2,175,700 lire. In its course it touches three mines of lignite, of the Eocene period, which furnish a con-



THE CONCENTRATION WORKS, MONTEPONI. THE UPPER FIGURE SHOWS THE ORIGINAL WORKS; THE LOWER, THE LATER CONSTRUCTION.

siderable return traffic. Porto Vesme (shown on page 944), where the railroad ends, near to the village of Porto Scuso, has a dock basin dug out in the marsh of Canelles, ample storage houses with a capacity of 6,000 tons of ore, and a harbor protected by rocks for a distance of 250 metres; vessels of a carrying capacity of 200 tons can reach the wharves.

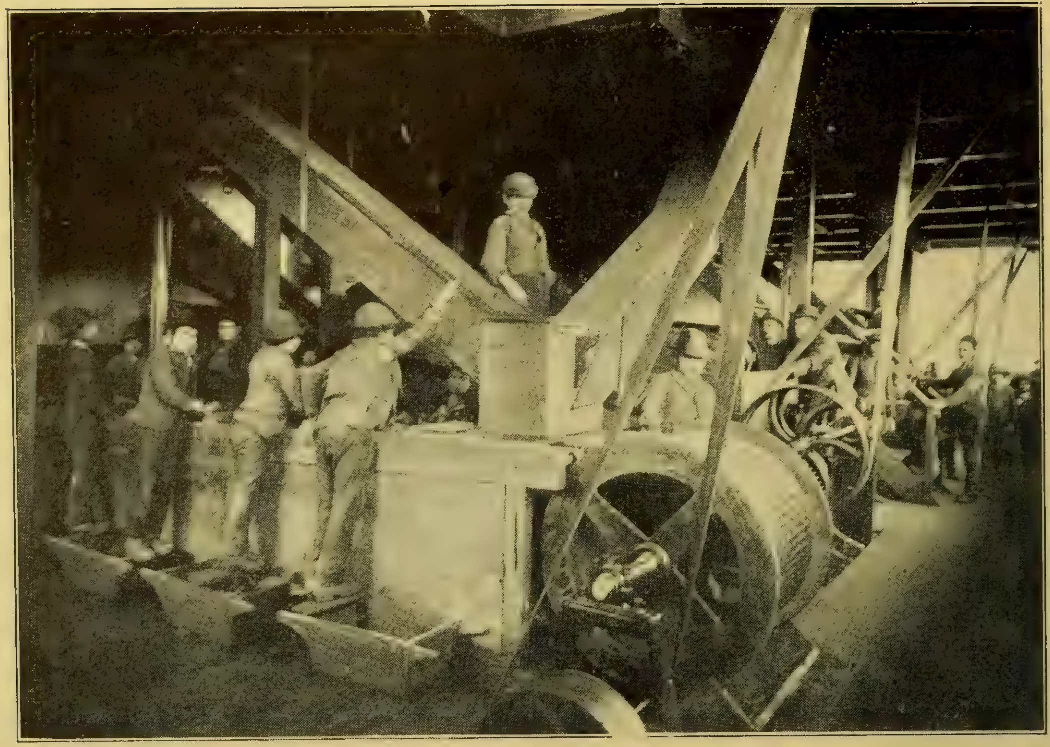
The first mechanical concentration works (page 945), situated between the mine and the railroad station, were built in 1876, for the purpose of doing away with the numerous washings by hand in the treatment of the fine materials. In 1881 crushing machinery for the mixed ores was added to these concentration works; and in 1890 they were finally completed and equipped so as to be able to treat every kind of material. They are divided into two sections; the principal one consists of two oscillating separators, two vanners, twelve sieves and six vibrating tables; the second—the machine section—contains a crusher, two crushing rolls, an oscillating separator and six sieves. In 1884 a second concentration works began operation; it consists at present of three sections—one for treating rock as mined, containing three oscillating separators, two vanners, ten sieves and three



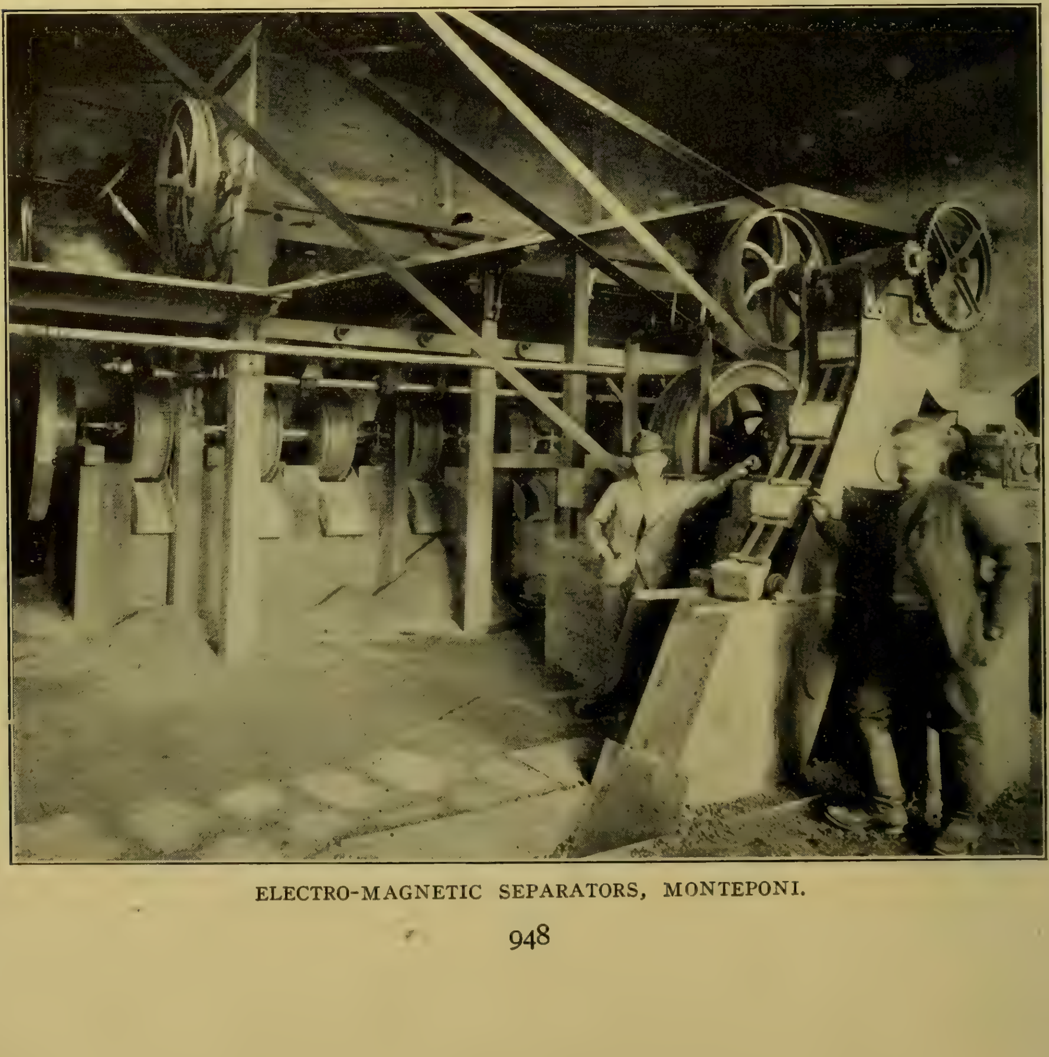
CALAMINE CONCENTRATORS, MONTEPONI.

THE MONTEPONI SMELTER.

vibrating tables; the second for crushing the mixed materials and separating the different ores from them, containing a Ferraris mill, an oscillating separator, six sieves and four vibrating tables; the third for the magnetic separation of the ores of iron and zinc, containing a magnetic separator with six electromagnets, and nine sieves. The first section treats three tons per hour, each of the other sections one ton per hour; 60 horse power is consumed. In 1887 the calamine concentration works (shown above and on the following pages), situated above those just described, and intended for the treatment of zinc ores from the upper part of the mine, was put into operation. In 1890 a magnetic concentrator was added to it, for separating mixtures of iron and zinc, which form a by-product of the calamine concentration works. The present equipment of these works consist of one crusher, eight grinders, four continuous vanners, eight separators (by which grades of separation of 1.5, 3, 5, 7.5, 10, 14, 20, and 30 millimetres are obtained), seventeen single sieves, eight double sieves, eighteen quintuple sieves, and three vibrating tables. The power required by the calamine concentration works is at present 120 horse power, while 20 horse power more are consumed by the magnetic separators and the rotary furnaces for roasting the concentrated ores of zinc. In each concentration plant a quantity of water circulates, serving to



HAND PICKING THE ORE, MONTEPONI.



ELECTRO-MAGNETIC SEPARATORS, MONTEPONI.

clean the materials, to effect the separation of the ores, and as a vehicle to carry off the clay or mud. If that water was thrown away after having passed through the works it would be necessary to provide at least 3,300 cubic metres of fresh water per day, which would have to be raised at considerable cost from the level of the sea. To prevent this expense, each plant is provided with large settling reservoirs for the waters containing suspended matter, and also with pumps for circulation; and the actual consumption is reduced to that of the water evaporated. The supply of water is maintained, and drinking water is provided for the works, by means of a double conduit 7 kilometres long, which comes from springs at the north of Monteponi.

LEAD SMELTING FURNACES, MONTEPONI.

In 1894 the lead and silver smelting works, near to the principal shaft (page 950) went into operation. It began with the treatment of easily reduced ores, with a production in the first year of less than 300 tons of lead; the output developed gradually in proportion as the personnel gained experience, and in the past year the production reached 4,200 tons, obtained partly from ores belonging to the mine and partly from purchased ores. The ore is first ground in a mill and then desulphurized and agglomerated in reverberatory furnaces. These roasting furnaces are four in number, two on the

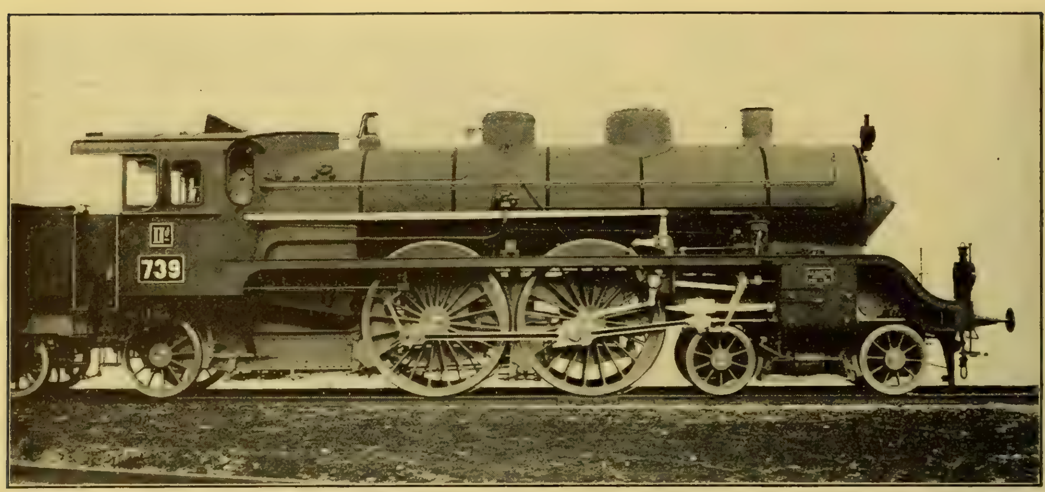
BOTTOM OF THE MAIN HOISTING SHAFT, MONTEPONI.

upper story of the foundry and two on the lower. One of the latter, smaller than the others, serves also for the treatment of certain secondary products, such as the metallic products from the blast furnaces. The agglomerated material in the roasting furnaces passes into the blast furnaces, of which there are two, one with six and the other with eight tuyeres.

The air is supplied to these furnaces by two blowers of the Enke type, each driven by an individual motor. Ordinarily one of the two is in operation and delivers the air under a pressure or 30 millimetres of mercury. The lead obtained from these furnaces passes into a tempering furnace to free it from impurities, and then goes to one of the two hemispherical heaters, where the silver is extracted by the zinc process. Two products are obtained from these silver-extraction heaters: The triple alloy, Zn—Pb—Ag, which passes to the silver section, and the desilverized lead. The latter passes to a final furnace, in which it is purified from such zinc as it may still contain, and from which it flows into a stock heater, from which it is cast by means of an iron siphon into moulds arranged in a semicircle around the heater, and the pigs obtained in this way are carried to the store house. The triple alloy is treated in a graphite crucible; the zinc distils and is recovered in part; the lead residue, rich in silver, passes finally to the cupel. In 1889 a zinc furnace was added for the purpose of extracting the zinc from the lead-bearing calamines and using the residues as ores of lead, which pass to the lead foundry. The calamine reduction furnace, with 180 crucibles, has a capacity for treating 7,200 kilogrammes of ore per day.

As an accessory of this industry a complete factory for refractory materials has been built, provided with machinery, grinders, kneaders, hydraulic presses, etc., for the manufacture of all kinds of refractory products, crucibles, zinc condensers, moulded pieces of every shape, and refractory bricks; there are immense dryers, roasting furnaces with a capacity of 25,000 bricks, and motive power of 40 horse power. These metallurgical works with their accessories have a present value of 700,000 lire. Besides commercial lead, they produce refined silver, zinc, and hard lead.

A machine shop with foundries for iron and brass completes the series of industrial installations of the Monteponi mine, and serves for the repair of the varied machinery in use, as well as for the construction of new machinery.



FOUR-CYLINDER COMPOUND LOCOMOTIVE BY J. A. MAFFEI, MUNICH.

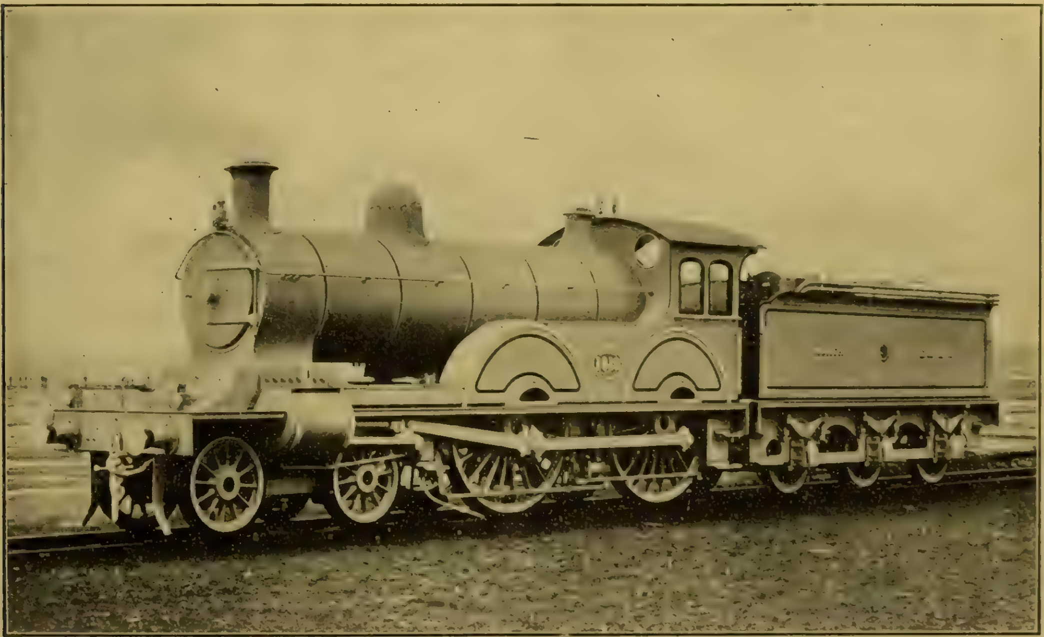
THE DEVELOPMENT OF THE COMPOUND LOCOMOTIVE IN ENGLAND.

By W. E. Dalby.

Professor Dalby's articles are designed to be a brief discussion of the mechanical aspects of compounding as applied to the locomotive, and a rapid survey of the actual development which has taken place in the quarter-century since its first introduction. This first section deals with the work of Mr. Webb, the foremost of the English engineers who have worked on the problem. A concluding section will treat of other designers. The illustrations widen the field and show the latest products of America and the Continent as well as Great Britain. —THE EDITORS.

THERE is perhaps no question about which there has been so much difference of opinion amongst locomotive engineers as that of compound locomotives. All are ready to admit that in certain circumstances a compound engine is more economical with regard to fuel and water than a simple one, but since, in general, compounding means increased mechanical complexity and increased maintenance costs, locomotive engineers are certainly not unanimously of opinion that the saving is a real one.

The first object that a locomotive engineer has in view is to build an engine which will keep time under adverse weather conditions and with a stated maximum load. The weather conditions are so variable that an engine designed to meet this requirement must have reserve boiler power and large grate area with correspondingly large heating surface, and for fast running, or rather high piston speeds, plenty of room in the pipes and ports for the steam to get out of the cylinders. If steam is to be had from the boiler, there is usually less difficulty in getting it into the cylinder than there is in getting it to exhaust freely. The second object of a designer is to design the engine so that whilst fulfilling the first condition it is economical with regard to fuel. If the second condition is fulfilled at the expense of the first, the economy obtained by decreased fuel consumption is false. Compound locomotives are stated to save about 14 per cent. of fuel, corresponding to about 5 pounds of coal per mile, and taking this at 10 shillings per ton the saving is about a farthing per mile. That is, one passenger is equivalent to four times the saving effected by compounding, because he pays at least a penny per mile. From the economical point of view therefore it is more profitable to cultivate passengers by excellent and unfailing time keeping. If the two conditions of design can be fulfilled by a compound, then, weight for weight, the compound engine is more powerful, because the size of the boiler has been virtually increased in the compound engine to the extent of the saving of steam effected. These considerations show what a difficult problem the locomotive engineer handles when dealing with compound locomotives. "Is it worth while to compound?" is the question which forces itself into notice. Some eminent locomotive engineers have decided that it is worth while, and that economy in fuel may be obtained without sacrificing efficiency in other respects. Others, equally eminent, believe that it is not worth while, and think that a simple engine is to be preferred for the peculiar conditions of locomotive work.



THREE-CYLINDER COMPOUND ON THE NORTH EASTERN RAILWAY OF ENGLAND.

The object of this article is to state a few principles by means of which the performance of a compound engine may be compared with that of a simple locomotive, and to give a brief account of the leading types which have come into use in Great Britain.

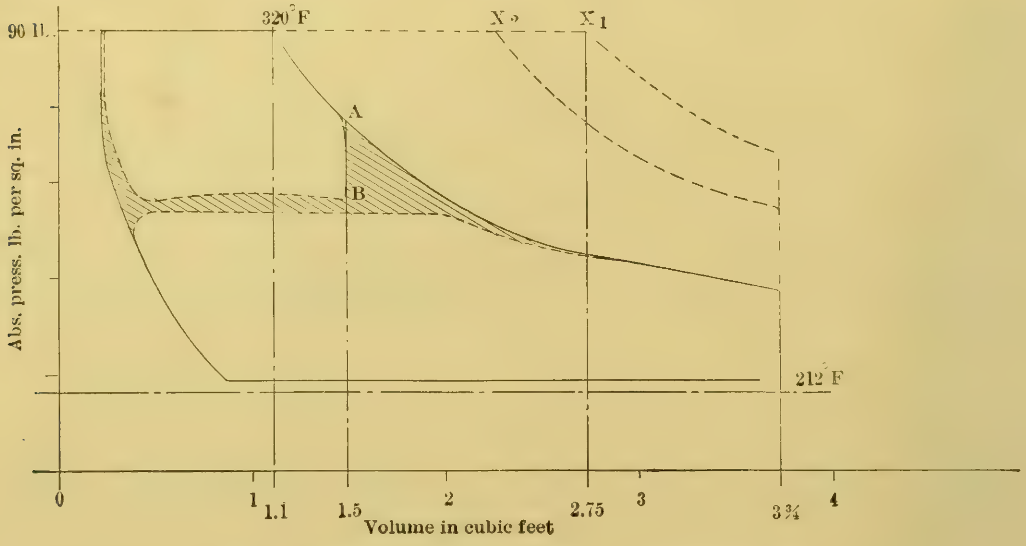


FIG. I. INDICATOR CARD FROM A SIMPLE ENGINE.

First, let us see what the nature of the problem is by the discussion of a numerical example. Consider the indicator card, Figure 1, taken from a simple engine. It is calibrated for pressure and volume so that the absolute pressure and the corresponding volume of steam shut in the cylinder can be read off at any point in the stroke. At cut-off the pressure is 90 pounds per square inch absolute and the volume 1.1 cubic feet. A reference to the steam tables will show that the volume of one pound of steam at 90 pounds pressure is 4.8 cubic feet. The inference is, therefore, that the weight of steam shut in the cylinder at cut off is 0.23 pounds. Now an independent measurement of the boiler feed disclosed the fact that the actual weight of steam passed into the cylinder per stroke was .0575 pounds. If none of this had been lost, the cut-off could have been arranged for a volume of 2.75 feet shown by the point X_1, on the diagram, since this is the volume corresponding to the actual weight of steam fed to the cylinder per stroke. The expansion curve would then have been somewhat as sketched, giving a large increase of work per stroke. The loss—that is, the difference between the actual weight fed to the cylinder and the weight accounted for by the indicator diagram—is usually put down to initial condensation, though probably a proportion of it is due to steam leaking through from the steam to the exhaust side of the slide valve. The cut-off point (and also every point on the expansion curve) on an indicator card from any steam engine is of necessity accompanied by a point X_1, giving the volume of the steam corresponding to the actual weight fed to the cylinder at cut off. The nearer X_1 approaches the cut-off point, the greater the economy of the engine. It has been found experimentally that as the cut-off is made earlier in the stroke the point X_1 moves farther away. In other words, increased expansion is accompanied by increased difference between the steam fed to the cylinder and the steam accounted for. There is, therefore, one particular ratio of expansion for a given condition of working where the gain due to expansive working is neutralised by the loss due to condensation. Another way of looking at the same thing is to consider the temperature variation of the steam. Observe that the temperature of the steam at cut-off is 320 degrees F., and at exhaust 212 degrees F., a difference of 108 degrees. It has been found by experiment that if the expansion of steam is carried out in stages, limiting the temperature difference in each cylinder to about 70 degrees, the condensation losses are considerably reduced. Let us consider now how the expansion of the steam may be carried out in two stages so that the same degree of expansion is maintained. Suppose steam to be admitted and cut-off as before when the volume has reached 1.1 cubic feet, Figure 1. Suppose further that expansion stopped when it has reached the point A on the curve, and that the pressure drops to the point B when communication is opened to the exhaust, which now takes place into a receiver of pipes communicating with the second cylinder in which the expansion is to be completed. The volume of the first cylinder must evidently be 1.5 cubic feet for this operation to be possible, and since the final volume is to be the same as in the case of undivided expansion, the volume of the low-pressure cylinder will be equal to the volume of the cylinder in which this undivided expansion can be carried out, namely, 3¾ cubic feet. The approximate shape of the indicator-diagram card is sketched in the figure. The whole ratio of expansion is the same as before, and is, (as always in a compound engine, no matter how many stages the expansion is divided into,) the ratio of the volume of the low-pressure cylinder to the volume of steam in the high-pressure cylinder at cut-off. By so dividing the expansion, the ratio of expansion and the temperature range in each individual cylinder is very much reduced so that the point X_1 should be nearer the cut off point. Considering the whole expansion it might move to a position X_2, indicating that a greater proportion of work is obtained from the cylinder feed per stroke. The effect of clearance and compression is neglected in the above explanation but it is inconsiderable and does not affect the general principle. Compounding therefore enables a range of expansion to be used without incurring so much loss by condensation as would be the case if the same range of expansion were carried out in a single cylinder. Figure 2 exhibits the volume of the high-pressure cylinder reduced to the stroke of the low-pressure cylinder. It would appear from the above that the volume of the high-pressure cylinder is largely a matter of choice. And so it is—but choice tempered with experience. The relative volumes are commonly arranged so that the work done in each cylinder is about the same. Although there is a reduction in condensation by compounding, the transfer of the steam from one cylinder to another cannot be made without loss. The work so lost in the hypothetical case Figure 1 is indicated by cross hatching; but notwithstanding this, with a properly arranged cylinder ratio and valve movement there is gain in economy. To further illustrate this point, Figure 3 exhibits diagrams taken from a North Eastern compound locomotive reduced to the same volume and pressure scale. The cross hatching indicates the work lost by the transference of the steam from one cylinder to another assuming that the expansion curve sketched in through the point of cut-off in the high-pressure cylinder would be that followed if the whole of the expansion were carried out in the low-pressure cylinder. This diagram also shows that the work is divided about equally between the two cylinders.

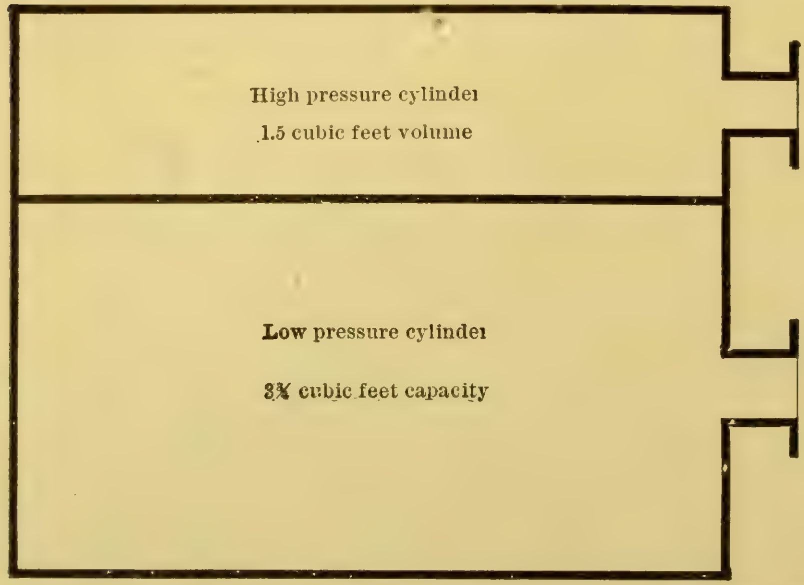
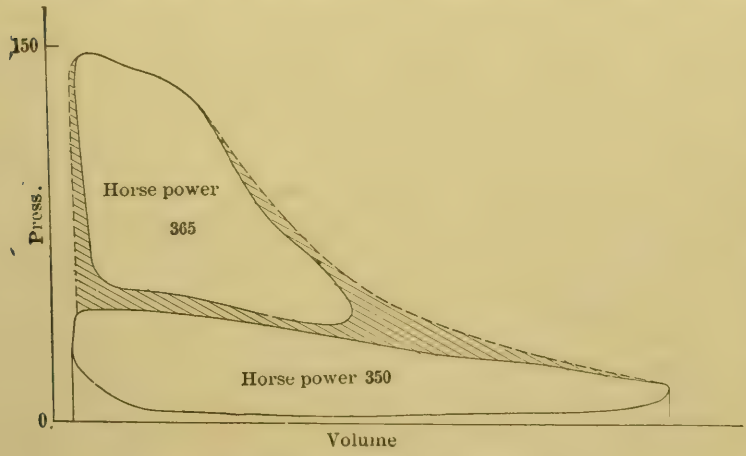


FIG. 2. VOLUME OF HIGH-PRESSURE CYLINDER REDUCED TO STROKE OF THE LOW-PRESSURE CYLINDER.

In the comparison of a simple with a compound engine with regard to their power, the combined volume of the low-pressure cylinders must be compared with the combined volume of the cylinders in a simple engine. Thus a simple engine with two cylinders each 18 inches in diameter and 24 inches stroke is equivalent to a two-cylinder compound with one low-pressure cylinder 25½ inches in diameter. In the design of a compound engine for locomotive work there is one point which differentiates the problem entirely from the corresponding problem in marine work. The locomotive has to start with it full load on—in fact, the pull at the drawbar is greatest when starting and for a few seconds it is necessary to take steam through as much of the stroke as possible in the simple engine. In a compound engine it is impossible to take steam to a greater extent than that permitted by the volume of the high-pressure cylinder. Various starting devices are used to overcome this difficulty; generally arrangements are made to admit steam directly to the low-pressure cylinder through some form of reducing valve. The best solution of the problem of compounding a locomotive would be the one which allowed the engine to work as a simple engine at starting, and possibly when working up heavy banks, taking a large quantity of steam per stroke, which could be changed to compound working at high speeds, with a high grade of expansion taking a small quantity of steam per stroke but as much per second as the boiler can supply.



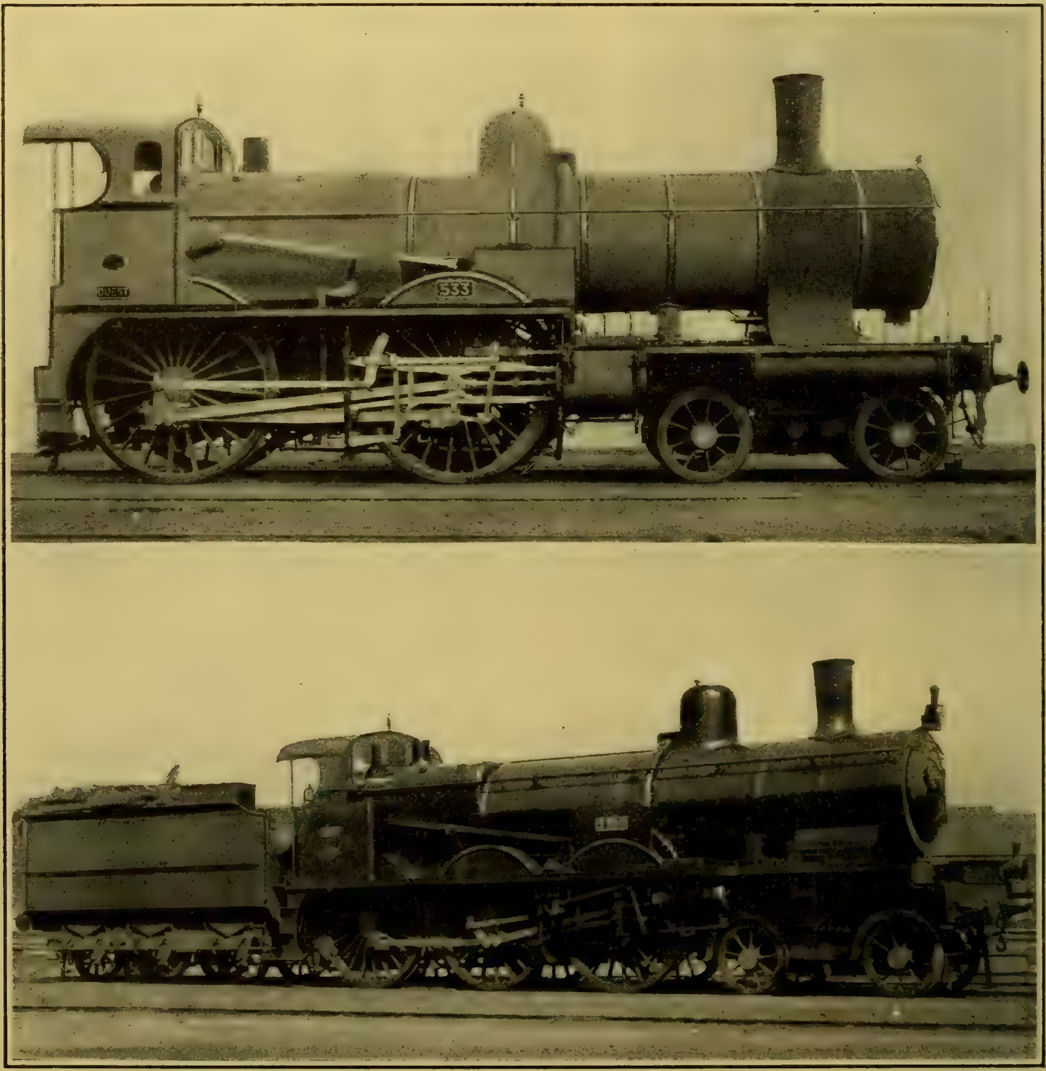
Boiler pressure 160 lb. to the sq. in.
speed 50 miles per hour.

FIG. 3. DIAGRAM FROM NORTH EASTERN COMPOUND.

Turning now to the consideration of what has actually been done in Great Britain; Thomas Craddock invented a compound condensing locomotive in 1846, and in 1849 John Nicholson invented what he called a "continuous expansion" locomotive. His idea was that the whole of the exhaust steam was not required for the blast; consequently between one-half and two-thirds of the steam supplied to the cylinder was allowed to exhaust into the blast pipe at a pressure considered necessary to produce the draught, the remainder being led to a second cylinder where it expanded to a lower back pressure.

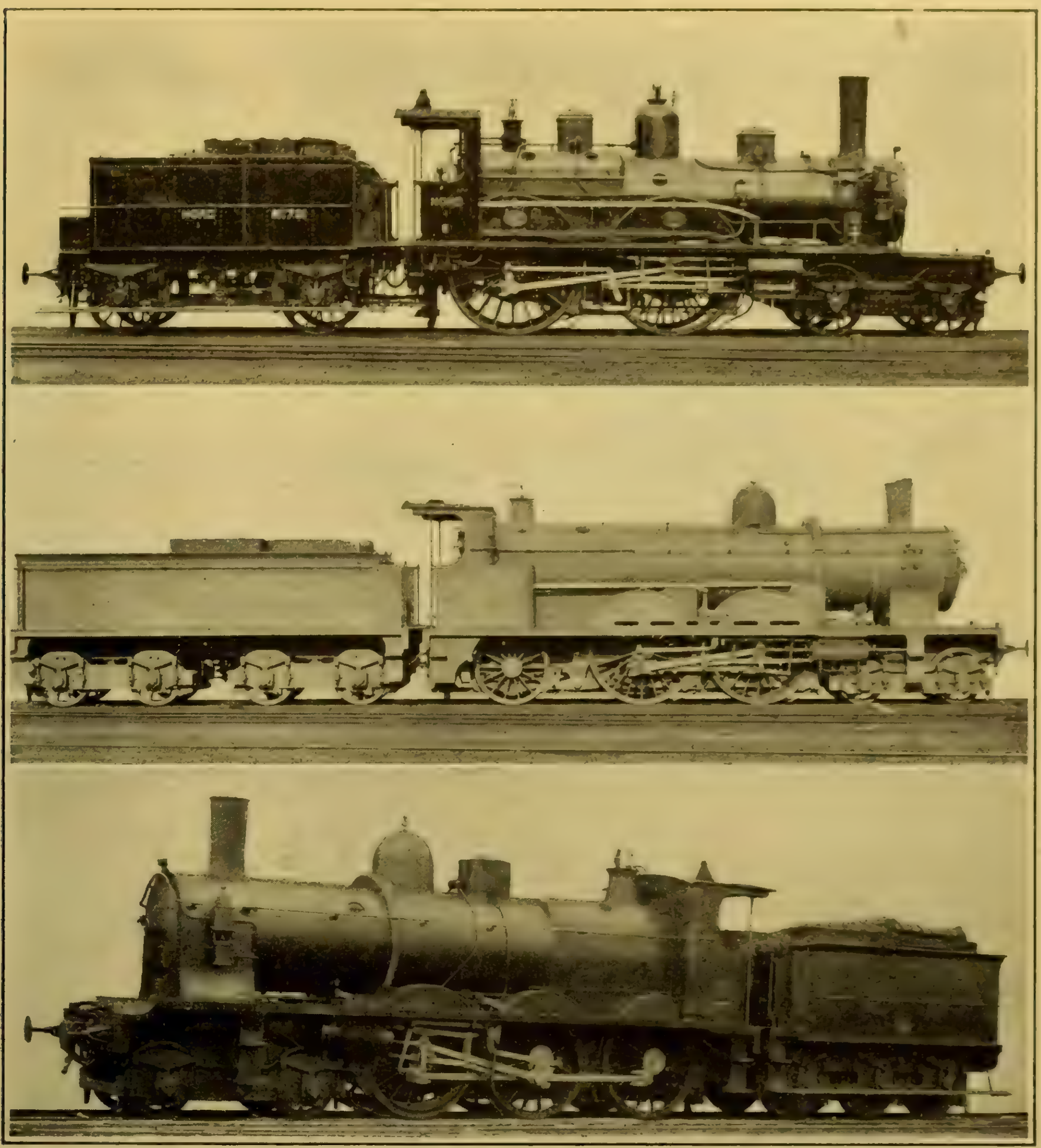
This engine was a compound in the sense that expansion was carried out in two stages, but it is doubtful whether it should be called a compound locomotive, because the aim of Nicholson was quite different from the aim of the designer of a compound engine. Nicholson's object was to expand down to a low back pressure and yet to maintain a high-pressure blast, and in designing the necessary arrangement he incidentally arrived at two cylinders. He apparently had no notion of carrying expansion out in two stages in order to limit the temperature difference in the two cylinders and thus save initial condensation.

The first true compound locomotive dates from 1876, when an



COMPOUNDS OF THE WESTERN RAILWAY OF FRANCE.

Above is a four-coupled four-cylinder bogie locomotive, cylinders 34 and 53 by 64 centimetres, weight 50 tons. Below is a six-coupled four-cylinder bogie locomotive, cylinders 35 and 55 by 64 centimetres; weight 65 tons.



A GROUP OF COMPOUNDS, NORTHERN RAILWAY OF FRANCE.

At the top is the 701, designed by de Glehn, and put into service in 1886. It has cylinders 33 and 46 centimetres diameter, 61 centimetres stroke, and weighs 41.45 metric tons. Next is du Bousquet's "Exposition" type 2642, designed in 1902 to maintain a speed of 100 kilometres an hour with a 200-ton train on a 0.5 per cent. grade; it has cylinders 34 and 56 centimetres by 64 centimetres and weighs 64.4 tons. At the bottom is a six-wheel coupled engine for fast freight and coal trains, hauling 950 tons on a 0.5 per cent. grade and 600 tons on a 1 per cent. grade at 40 kilometres an hour. Cylinders 35 and 55 by 64 centimetres, weight 58.57 tons.

engine was constructed at the Creusot Works for the Bayonne and Biarritz Railway Company on a plan proposed by Mr. Mallet. The first stage of the expansion in this historic engine was carried out in a cylinder whose volume was 0.72 cubic feet, and the second in a cylinder whose volume was 2 cubic feet capacity, the engine thus being equivalent to a simple engine with two cylinders each one-cubic-foot capacity. The pressure was 140 pounds per square inch. The trials with this engine proved that the two blasts per revolution from the low-pressure cylinder were capable of producing a draught sufficient to give plenty of steam.

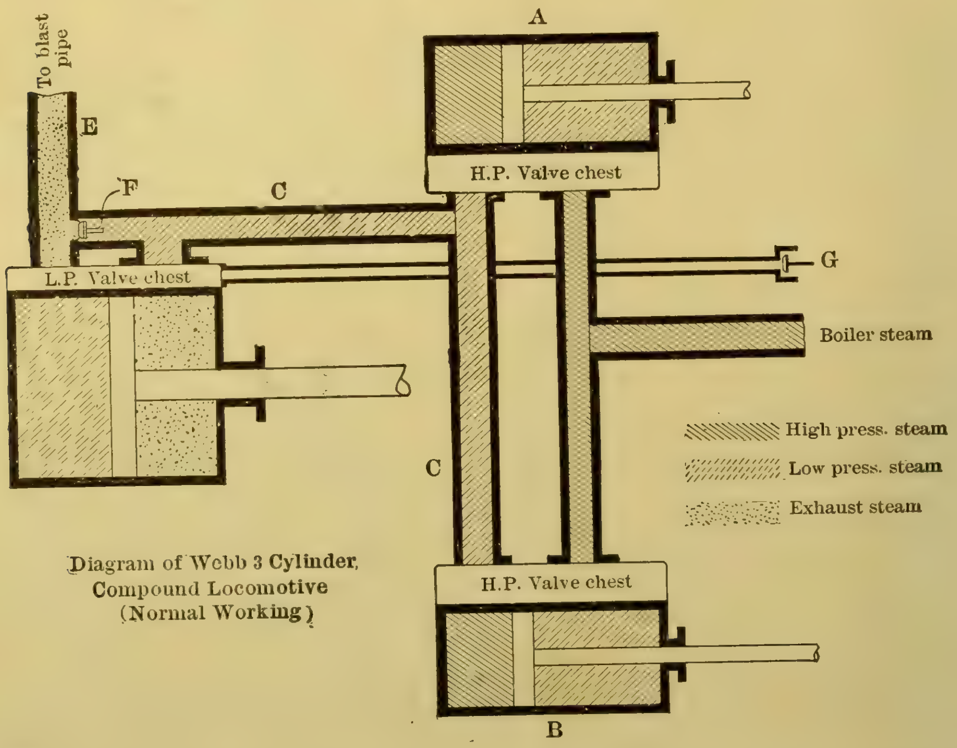
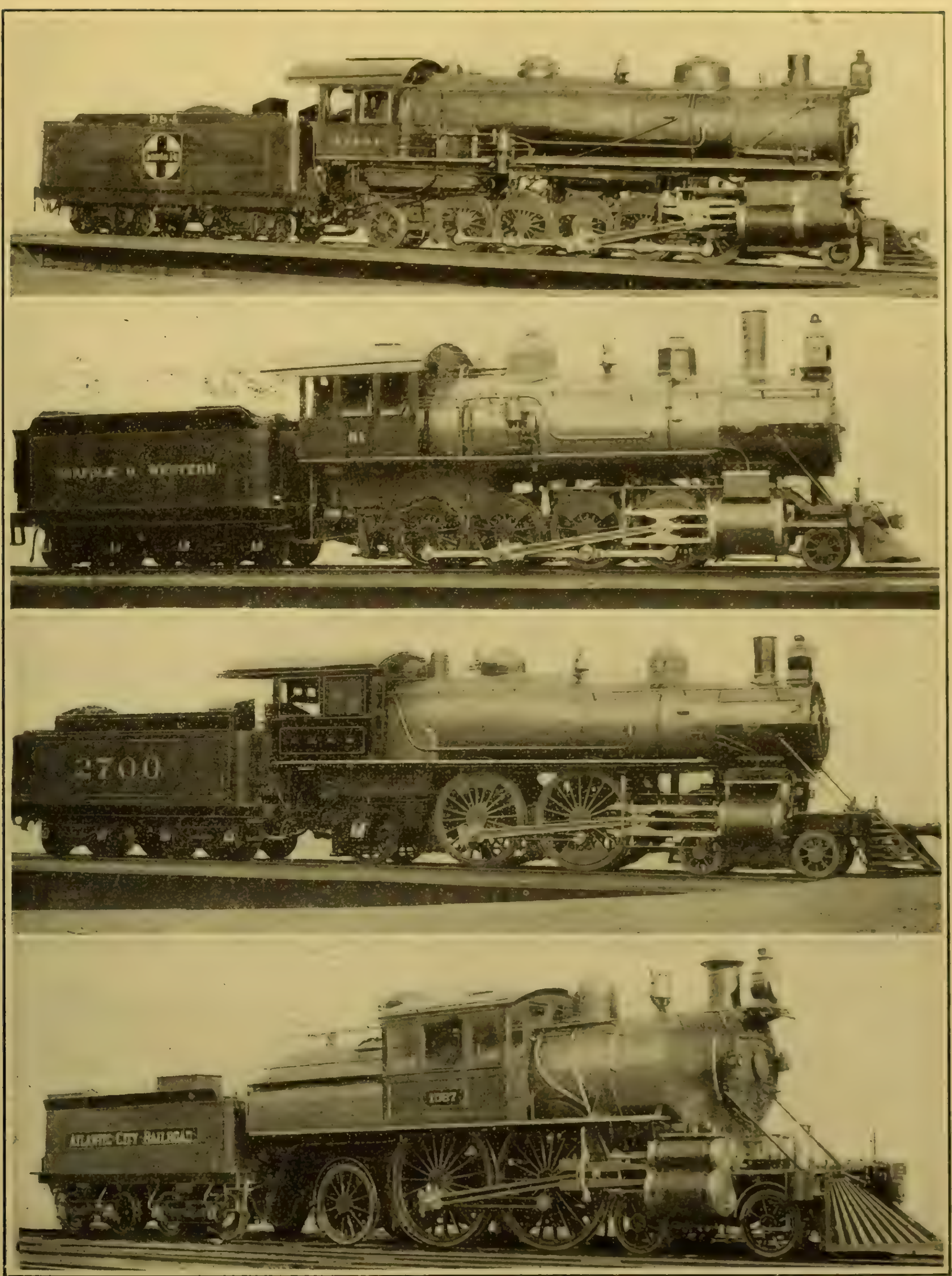


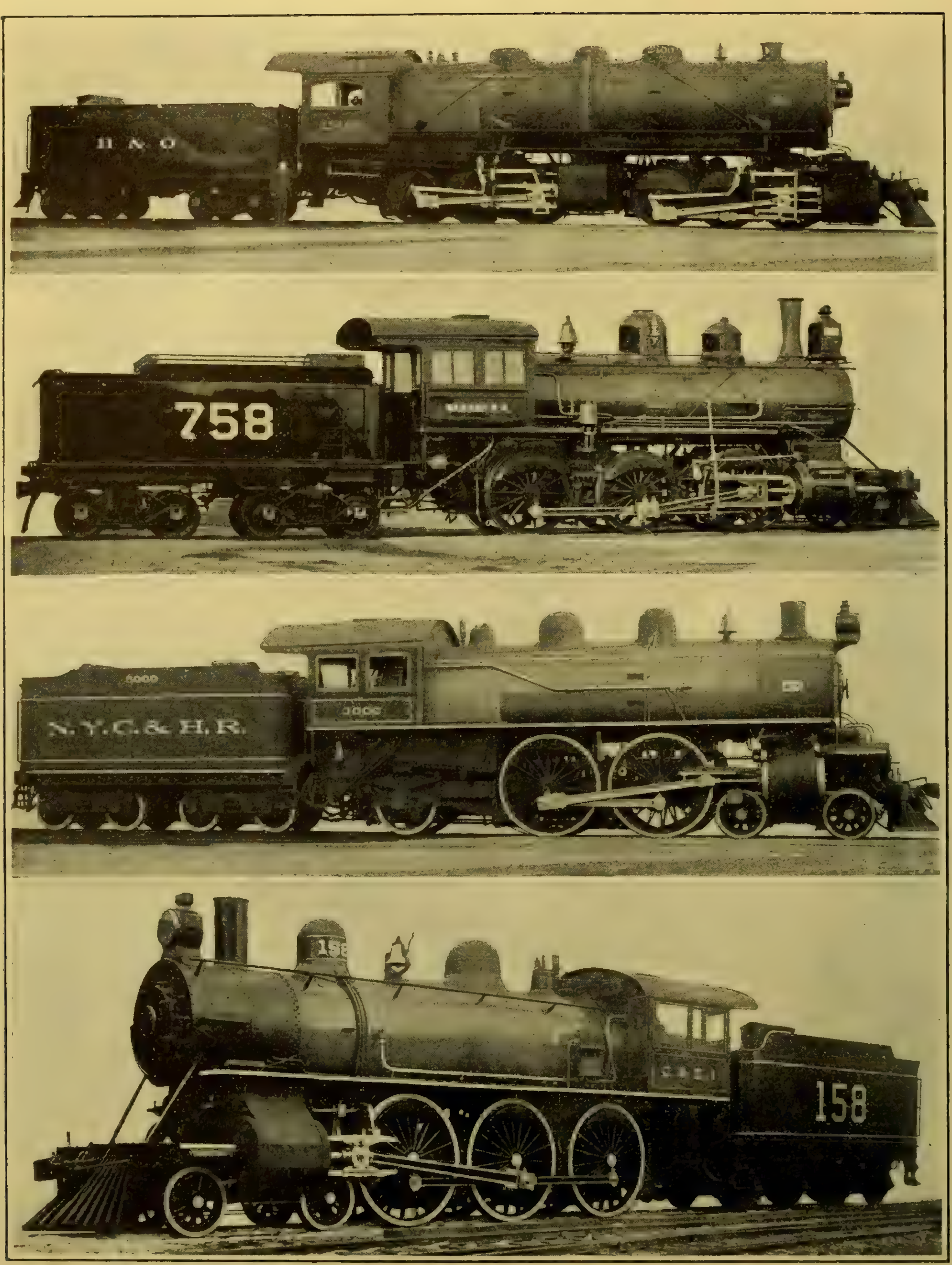
FIG. 4. DIAGRAM OF CYLINDER ARRANGEMENT OF WEBB THREE-CYLINDER COMPOUND.

The first true compound engine in England appeared in 1878 on the London and North Western Railway. Mr. F. W. Webb converted an ordinary single-wheeled outside-cylinder passenger engine into a compound of the Mallet type by the simple expedient of bushing one cylinder to 9 inches diameter, leaving the other to act as the low-pressure cylinder. This engine ran regularly on the Ashby and Nuneaton branch of the railway, and the results obtained led Mr. Webb to the design of the two-stage expansion three-cylinder compound which has since been associated with his name. The diagram Figure 4 indicates the arrangement. Two high-pressure cylinders, A and B, placed outside the frames, drive directly onto the trailing axle, the cranks being placed at right angles. The connections shown in the diagram indicate that the cylinders, so far as the expansion of steam is concerned, are to be regarded as one in which the first stage of the expansion is carried out. To use an electrical term, they are connected in parallel. The steam after partly expanding in these is transferred through the pipe C to the steam chest of a single low-



COMPOUNDS BY THE BALDWIN LOCOMOTIVE WORKS—BURNHAM, WILLIAMS & CO., PHILADELPHIA.

At the top, the Santa Fe 934—tandem-compound, "Santa Fe type"—cylinders 19 and 32 by 32 inches; 58.5 sq. ft. grate and 4,796 sq. ft. total heating surface; weight of engine 287,240 lb. Next, a cross-compound for the Norfolk & Western, cylinders 23 and 35 by 32 inches; 34.8 sq. ft. grate and 2,788 sq. ft. total heating surface; weight 186,000 lb. The third is a four-cylinder balanced compound, C. B. & Q. Ry., which recently hauled a 7-car train from McCook to Akron, 214½ miles, in 241 minutes running time. At the bottom is the Vauclain four-cylinder compound "Atlantic type," cylinders 13 and 22 by 26 inches; total heating surface 1,835.1 sq. ft.; weight 142,900 lb.



COMPOUND ENGINES, AMERICAN LOCOMOTIVE COMPANY, NEW YORK.

The topmost is a Mallet articulated for the B. & O., cylinders 20 and 32 by 32 inches; 72.2 sq. ft. grate and 5,585.7 sq. ft. total heating surface; weight 334,500 lb. Next is a Richmond compound mogul, Wabash R. R., cylinders 20½ and 32½ by 28; 31.97 sq. ft. grate and 1,578 sq. ft. total heating surface; weight 129,500 lb. Third is a Cole balanced compound, cylinders 15½ and 26 by 26 inches; 50.3 sq. ft. grate and 3,446.1 sq. ft. total heating surface; weight 200,000 lb. At the bottom is a 10-wheel compound, C. & E. I., cylinders 22 and 34 by 26 inches; 35.87 sq. ft. grate and 2,380.8 sq. ft. total heating surface; weight 174,400 lb.

pressure placed between the frames, and in this cylinder completes its expansion, finally exhausting into the blast pipe E. It will be seen therefore that the engine consists so far as the mechanical arrangement is concerned of an outside single of the ordinary type and a one-crank inside single engine in combination. There are no coupling rods. Consequently the two crank axles are at liberty to take up any angular relation to one another they please. One of the advantages claimed for this type was that it combined the advantages of a coupled engine with the freedom of running peculiar to the single engine. The pipes transferring the steam from the high- to the low-pressure cylinder are coiled round the inside of the smoke box in order that the steam as it passes through them may pick up what heat it can from the smoke-box gases.

It will be gathered from the diagram that the engine must in general start from the high-pressure cylinders alone. It may happen, however, that the low-pressure engine has stopped so that the slide valve covers both steam ports, in which case the exhaust from the high-pressure cylinders cannot get away, and if in addition the high-pressure wheels should slip, the steam accumulating in the pipe C would soon increase in pressure to such an extent that the engine would be locked, at it were. To avoid this difficulty a valve F, operated by the driver, opens a communication to the blast pipe and then the engine works as a two-cylinder simple. The driver can also introduce boiler steam direct to the low-pressure valve chest through the small valve G. A sketch of the actual arrangement of the valves F and G is shown in Figure 5.

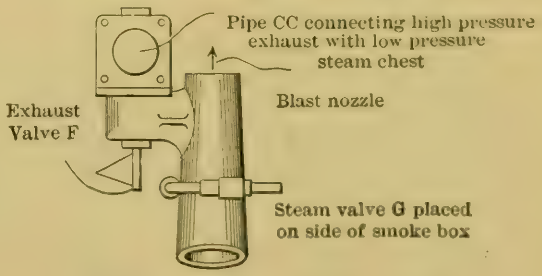
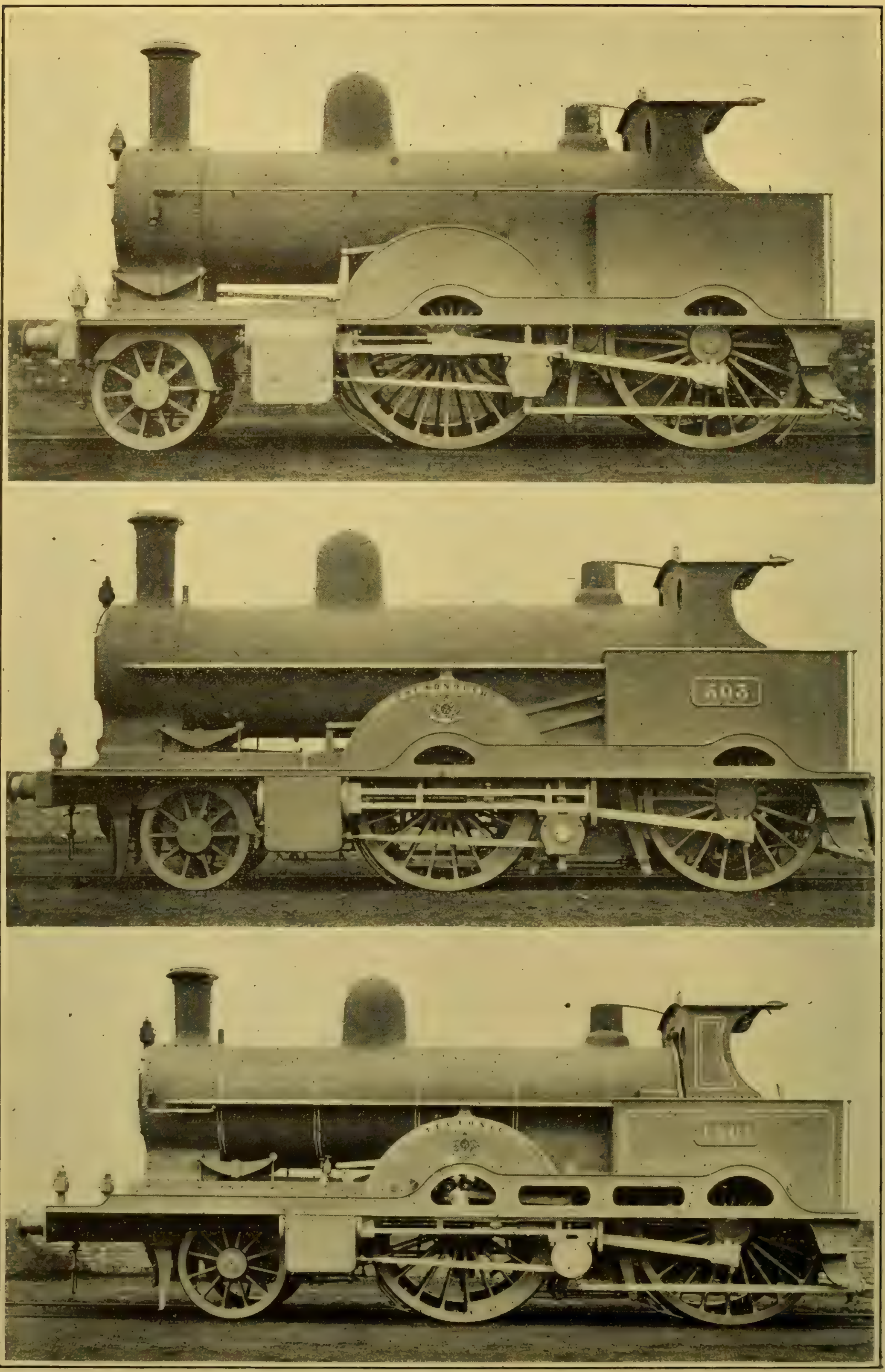

Pipe CC connecting high pressure exhaust with low pressure steam chest
Blast nozzle
Exhaust Valve F
Steam valve G placed on side of smoke box

FIG. 5. WEBB STARTING VALVE.

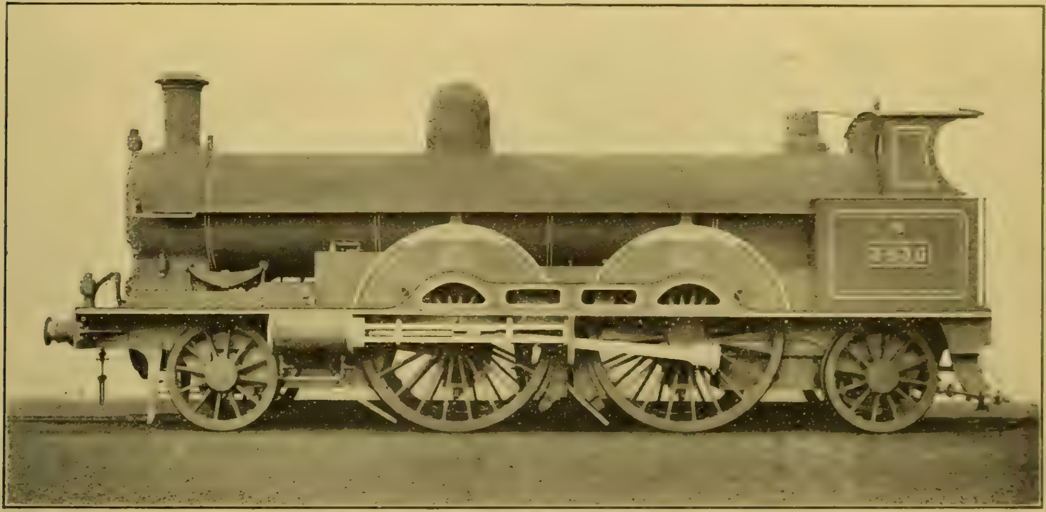
The first engine of this type, called "Experiment," was built in 1882. The high-pressure cylinders were each 11 inches diameter and 24 inches stroke, the low-pressure cylinder being 26 inches diameter and 24 inches stroke. The driving wheels were 6 ft. 6 inches diameter. A photograph of this engine is shown on page 964. Subsequently twenty-nine engines were built like her, with the single exception that the high-pressure cylinders were increased to 13 inches diameter. These were followed in 1884 by forty more, the "Dreadnought" class, with cylinder diameters enlarged in the case of the high-pressure to 14 inches, and the low-pressure to 30



WEBB'S EARLIER COMPOUND LOCOMOTIVES.

At the top is the first he built—the "Experiment," of 1882; next is the "Dreadnought," of 1884, with larger cylinders (14 and 30 inches); at the bottom is a later modification—the "Teutonic"—with larger drivers.

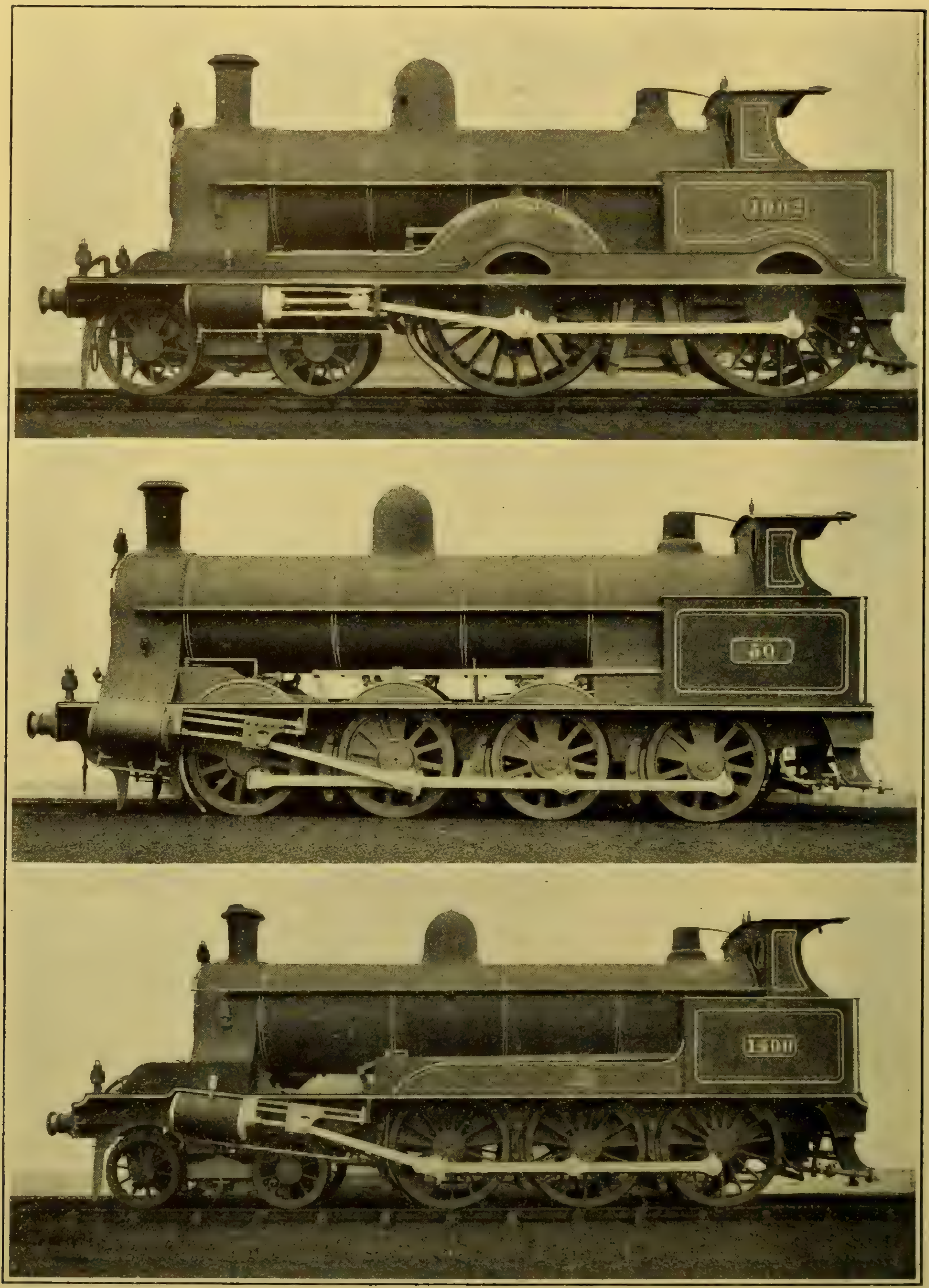
inches, the strokes remaining at 24 inches, but the wheels reduced to 6 feet 3 inches diameter. The boiler was increased in size and there were minor alterations made in details as will be gathered from the view, page 964. Then came ten of the Teutonic class, shown at the bottom of the page opposite, differing from the Dreadnoughts mainly, in having 7 feet 1 inch driving wheels. These were followed by ten having 15-inch high-pressure cylinders and known as the Greater Britain class. The most striking characteristic of this class, one of which is shown just below, is the long boiler, caused by the introduction of a kind of combustion chamber in the barrel about midway between the tube plates thus dividing the tubes into a leading and trailing set. Ten more of this type were built, the John Hick class, in which the driving wheels were reduced to 6 feet 3 inches diameter. Meanwhile the system had been applied to goods engines, but here the wheels were coupled and the cylinders were arranged together at the leading end to drive onto one axle. The two outside high-pressure cranks were placed at 90 degrees with each other and the low-pressure inside crank bisected the re-entrant angle between them. The cylinders were, high-pressure 15 inches diameter by 24 inches stroke, low-pressure 30 inches diameter and 24 inches stroke. Eighty-one engines of this class were put into service.



THE "QUEEN EMPRESS," ONE OF WEBB'S "GREATER BRITAIN" COMPOUNDS.

Cylinders 15 and 30 inches, stroke 24 inches, drivers 75 inches. The engine has a combustion chamber midway of the barrel, dividing the tubes into two sets.

It may be mentioned that the Experiment and Dreadnought class were fitted throughout with the Joy gear. In the Teutonic class the Joy gear was retained for the high-pressure cylinders but was replaced on the low-pressure engine by the single loose-eccentric gear



WEBB FOUR-CYLINDER FOUR-CRANK COMPOUNDS.

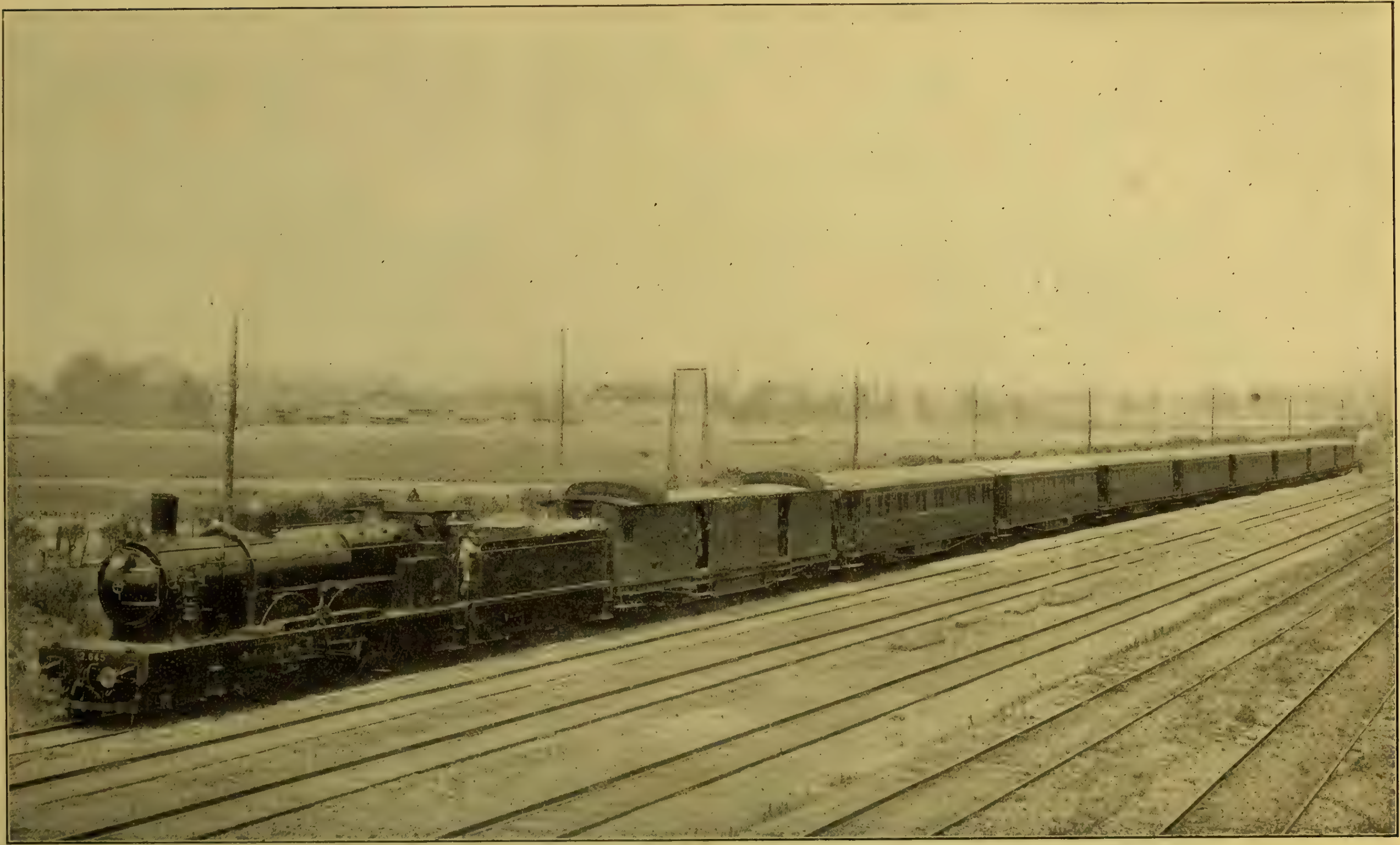
The uppermost is the first of the class, brought out in 1897; in the middle is a freight engine, compounded in the same way; at the bottom is one of Mr. Webb's latest engines of the same type, designed for freight traffic.

CONSOLIDATION COMPOUND BUILT BY ROGERS LOCOMOTIVE WORKS FOR THE GREAT NORTHERN RAILWAY.

Cylinders 22 and 33 by 32 inches; 35.45 sq. ft. grate and 2,812 sq. ft. total heating surface; weight 194,000 lb.

so that the engine really reversed entirely by the high-pressure cylinders. The succeeding engines were fitted with the Stephenson link motion for the high-pressure cylinders and the loose-eccentric gear for the low-pressure.

In 1897 Mr. Webb made a new departure with four-cylinder four-crank compounds. Connecting rods were again introduced, and the four cylinders drive directly onto one axle. The engine, so far as the steam distribution is concerned, consists of two two-cylinder compound engines placed side by side. The outside high-pressure cylinder and the adjacent inside low-pressure cylinder on the one side form one engine, the corresponding cylinders on the other side forming the second engine. Each engine drives cranks placed at 180 degrees, the 180-degree pairs being placed at 90 degrees. The high-pressure cylinders are each 15 inches diameter and the low 20½ inches, the strokes of all 24 inches. The high-pressure cylinders have piston valve, the low-pressure balanced slide valves. The Joy valve gear is used to work the low-pressure valve direct, and the valve spindle is extended through the leading end of the valve chest and gearing with a lever works the high-pressure valve. Thus one valve gear is made to operate the two valves. There are therefore only two gears for the four cylinders. The steam pressure used in this type is 200 pounds per square inch. The upper figure opposite shows the first of the class, the "Black Prince," and the next an 8-wheeled goods engine compounded in a similar way. Mr. Webb's last contribution to locomotive engineering is the handsome six-coupled compound goods engine shown at the foot of page 966. It is of the four-cylinder type, the high and low-pressure cylinders being respectively 15 and 20½ inches diameter and 24 inches stroke, and the wheels 5 feet 6 inches diameter



THE EXPRESS FROM CALAIS TO PARIS, NORTHERN RAILWAY OF FRANCE, DRAWN BY A NORD COMPOUND.

The train is composed of eight coaches and a baggage car. It is 640 feet long, and weighs 300 tons (metric) behind the engine, which itself weighs 109 tons.

THE ELECTRIC EQUIPMENT OF WORKSHOPS AND FACTORY BUILDINGS.

By Percival Robert Moses.

In the following article Mr. Moses summarizes briefly the typical manufacturing uses to which electricity may be applied, the main essentials of the apparatus and installation required in the various instances, and the characteristics of the several types of motors, indicating their adaptability to the various kinds of duty for which they may be installed. —The Editors.

THE applications of electricity in factories and in other buildings used for manufacturing purposes are continually increasing both in quantity and wideness of scope. Electricity is used for lighting, for power, for high-temperature heating (replacing gas), for chemical and metallurgical processes, and for signalling and transmission of intelligence. The great advantage of electricity for power transmission has been demonstrated in many different ways, and I will merely touch on the more valuable features such as its flexibility and ease of transmission, cleanliness, reliability, elasticity in application, its protective features, and the ease with which it is measured, all of which are generally equal, if not superior, in importance to the possible saving in fuel by reduction in friction losses.

The flexibility of the electric system with its readily removable wires and motors, and the absence of any fixed location of countershafting, has been enlarged upon many times; it offers to the manufacturer real advantages, hard to fix in dollars or pounds, but just as actual and valuable. The director of the largest printing office in the United States told me that he had tabulated results and studied them with great care with the conclusion that he obtained over 20 per cent. more work from a given set of operators and machines with the electric equipment than he had with the old countershaft method, and his experience has been the experience of many others controlling large establishments. This result is due largely to the ability to adjust each piece of apparatus readily to the most economical speed, both as to the machine itself and the operator.

The ability to control and regulate the operation of apparatus at a distance by simple push buttons or switches is another advantage. In one pumping system, pumps drawing from wells situated miles apart are started and stopped from a central point by opening or closing switches, and in this instance a telephone is used to allow the operator to hear if pump is operating regularly.

Electricity in power transmission and application is as reliable as mechanical devices, the only part subject to trouble being the motor. With ordinary care and proper design, this piece of apparatus should wear indefinitely and not cause as many shut-downs as the breakage of belts.

The ease of measurement is especially valuable in buildings devoted to manufacturing purposes but occupied by separate users of power. In older buildings of this type, the method employed involved the use of a slow-speed steam engine belted to a vertical shaft, and this in turn belted to various countershafts on the different floors. The leases provided that the tenant was to be allowed 8, 20, or 50 horse power, as the case might be, and this horse power was estimated from the tenant's idea of what he would require. If the tenant's business increased, there was no satisfactory way of determining the increase of power supplied, as the variation in load from moment to moment in almost all cases made a definite determination of power impossible. Even if this power was determined fairly accurately for one day, by means of a transmission dynamometer and indicator cards, it was no criterion for the next day's use, or the use a month after.

Under the electric system, with a meter measuring accurately and registering the total quantity of power used, or more correctly the energy supplied, the tenant pays for what he receives, and the seller can make his charges more equitably to the different tenants. This also results in more economical apparatus and less waste in its employment. It is a fact shown in several examples that the quantity of electricity used without meter was two or three times that used after meters were installed. The protective feature is also important, as by means of circuit breakers and fuses stopping the flow of current automatically at a fixed amount, the limit of strain to a given piece of machinery may be fixed and serious damage through overload averted.

The use of electricity for lighting preceded its use for power, but its great development has been coincident with the increase in its use for power purposes. It has all the advantages of all other illuminants, and few of the disadvantages. In the form of incandescent lamps it replaces gas for localized lighting, and in the arc light we have the nearest approach to daylight so far obtainable—that is, a diffused and general illumination.

The use of electricity for heating is apparently uneconomical, as is evident when it is remembered that rarely more than 5 or 6 per cent. of the heat energy in coal can be converted into electrical energy; but as gas has replaced coal for localized high-temperature purposes, electricity is in turn replacing gas. The reason for this is not entirely a question of comparative cost of the two supplies. In general, however, it is cheaper to heat by electricity than by gas, where electricity is supplied from a private plant for other purposes and the whole or part of the exhaust steam from the engine can be used. This has had a great deal to do with its introduction in large hat factories where great quantities of low-pressure steam are required for other purposes. Besides, it is not a case of comparing the cost of manufacturing gas with the cost of manufacturing electricity. The cost of manufacturing gas is but a small percentage of the selling price, and it is this price which is to be compared with the cost of adding a certain amount of electrical output to the previous output of the plant; that is to say, the cost of the additonal output is ordinarily limited to additional coal and additional fixed charges, labor, oil, waste, and other supplies remaining the same with or without electric heating. Frequently in small plants the electric heating serves merely to raise the average load of the engine during the day run, and the increase in coal required is not in proportion to the increase in energy supplied. Under these conditions, electricity may cost the manufacturer much less than gas. Where this is not the case, and the electricity for heating costs more, the reduction in fire risk, freedom from production of poisonous gas in the rooms, concentration of the heat, and its cleanliness, free from deposit of soot and similar objectionable attendants, render its use advisable.

Almost all the modern hat factories are equipped with heating apparatus for ironing, glue kettles, and dozens of special applications. Printing offices are using electric heating apparatus in a great variety of ways. Dental companies use it for their moulds. It is used for ruffling machines, ironing, pressing, and in fact is doing the work that gas did with more satisfactory results. In one instance where the energy is derived from a large water power, electricity is used to heat water and small rooms,

For usual temperatures the heat is obtained by causing a flow of electricity through small wires, the energy used in overcoming the resistance being transformed into heat.

Where a high rate of heat emission per square inch is desired, with results similar to those obtained from direct gas flames or Bunsen burners, low electric pressure (voltage) must be used so that the resistance wires may be close together, the insulation light, and the amount of current for a given quantity of energy comparatively heavy.

Where a low rate of heat emission is needed, the voltage may be higher, but in no case should it exceed from 120 to 130 volts. It may be well to explain the reason why a lower voltage is desired:—a given quantity of energy, as for example, one kilowatt, requires 5 amperes at 200 volts, or 50 amperes at 20 volts. The loss of energy, that is to say the heat developed in passing through a given resistance, is equal to the square of the current (amperes) multiplied by the amount of resistance (ohms); hence in the instances just cited, if we wish to use up 1 kilowatt of energy and develop this quantity of heat, with 200 volts we would have to have a resistance of 40 ohms, and with 20 volts we would only need 2/5-ohm resistance. In order to get 40-ohms resistance a great quantity of fine wire, all of which would have to be insulated, would be required and this wire and insulation would be mechanically weak and the heating would not be evenly distributed on account of the necessity of superimposing several layers of wire. In the second case we would need a small quantity of heavy wire, the apparatus would be strong mechanically, and the heat could be uniformly distributed without difficulty.

Where very high temperatures are required, apparatus similar to an arc lamp is used, the heat being developed between the carbons forming the terminals of the arc and the arc enclosed in a suitable heat-resisting furnace. This is the process used in melting refractory metals, and by Moissan, in manufacturing small diamonds in his famous experiment.

The application of electricity to chemical and metallurgical processes is special work and has a field all its own. In these lines notable examples of the chemical and metallurgical uses are electro-plating, electric refinement of gold, the manufacture of sodium and carborundum, the fixation of nitrogen from air, and the removal of iron impurities.

The two main systems of distribution for the diverse purposes outlined are direct and alternating-current systems. In a paper written for The Engineering Magazine in September 1901, the comparative value of these systems was discussed, as well as the best voltages to be used. Since the writing of this paper, the conditions have not changed materially, although the manufacture of alternating-current apparatus has been taken up by more large companies, the apparatus has become better standardized, and the development carried on to greater perfection; but the alternating-current apparatus is still more expensive than that for direct current, without apparent reason except the greater competition existing in the direct-current work. In my opinion, the 125-volt, two-wire system is still the preferable one in most instances. Where electric heating with a high rate of heat emission requires a large proportion of the energy supplied, alternating current may be used to great advantage. With this type of current, transformers may be used to reduce the pressure and increase the current in direct proportion. This can also be done with direct current, by rotary transformers, but not in as convenient a way as with the alternating current. The other conditions under which the alternating-current system is advisable were fully covered in the paper mentioned above.

The question of speed variation of tools by change in speed of motors has been the subject of a great deal of work during the past few years, and the articles which appeared in the recent numbers of The Engineering Magazine covered the field quite fully.* For ordinary cases other than direct-connected tools, the speed variation obtainable by variation of the field strength is sufficient and the two-wire system is advisable. Where a finely divided and adjustable speed control on large motors is wanted, multiple wiring with different pressures (voltages) between sets of wires is necessary, or some mechanical speed changer such as the cone pulley must be adopted.

In designing the equipment for a factory or manufacturing building, it is advisable that the electricity for lighting and the electricity for power shall be supplied from different mains controlled by different switches on the switchboard. The object of this division is to prevent flickering of the lights with variations in motor load. If lights are taken off the same line as supplies the motors, an increase in the demand on this line, will cause a drop in pressure on the line itself and hence cause a variation in the lights. There should be no drop in pressure at the dynamo terminals, as the engine governor will keep the engine speed sufficiently constant to prevent a change in electric pressure with increase or decrease in load; hence by taking the lighting connection at a point as near to the dynamo as possible—that is to say, the switchboard—trouble in the lighting due to variation in motor load is minimized.

Where factories are of fireproof construction, it is usual to run the wires concealed in iron conduits, but where the buildings are of ordinary mill construction, wires for lighting or small motors are run exposed and supported on porcelain knobs or cleats spaced not more than 4 feet apart. It is advisable to sub-divide the motor circuits as much as possible without undue complication; this is particularly important where a constant speed is desired.

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* The Development and Use of the Small Electric Motor, by Fred. M. Kimball; The Engineering Magazine, April-July, 1903.

The mains to supply the motors, lights, and other apparatus are run from the switchboard, located in the engine room, to small switchboards at each floor, called panel boards, and from these circuits are run to the motors, circuits usually being terminated in the starting resistance, which may or may not have a switch mounted on its cover. The starting resistances should be equipped with protective devices to cut off the electricity in case of momentary overload sufficient to damage the motor, and with a similar device to cut off the electricity should the electric pressure be removed by the blowing of a fuse or other cause. The heavy leads to the motors are almost invariably run in iron pipe.

The choice of motors is one involving careful study of the requirements of the apparatus to be driven; the types differ as the work varies. Of direct-current motors there are four types; viz.:—the series, the shunt, the compound, and the differential. Of alternating-current motors there are the single-phase, two-phase, and multiphase (three or more phases), and these latter are in turn sub-divided into those starting with a throttling resistance connected to brushes, and those starting without throttling resistance, having no brushes. There are others known as the repulsion type and the series type, but these were designed for railway work and as yet are not in extended regular use. These motors of any type may be designed for any voltage, but the standard voltages for direct current are 80, 110-125, 220-250, and 500; for alternating current, 100, 200-220, 400-500, and 1,000.

The series direct-current motor is applicable to work requiring a speed varying inversely as the load and a large power for starting. Such a motor is usually employed for cranes, hoists, and street cars.

The shunt motor is used in the great majority of applications, and is suitable where it is desired to obtain a speed constant within 5 or 10 per cent. throughout a range from no-load to double full-load. The shunt motor has a strong starting power, but where especially strong starting ability is desired and constant speed is not essential, the compound motor is used, as this combines the features of the series and shunt machines; the more a motor is compounded, i. e., provided with a magnet winding through which the main current passes, the more closely it resembles the series motor. Elevator motors, heavy punch and roll presses, large printing presses, mills for crushing and grinding, etc., are usually provided with this type of motor.

The differential type is more seldom used, and it is designed to obtain absolutely constant speed under varying conditions of load, or an increased speed with increase of load.

In the alternating-current types, the single-phase motor is handicapped by its inability to start under heavy load (unless equipped with special apparatus) or to carry excessive overloads. It has good electrical characteristics from the plant standpoint, as it is simple and has a high "power factor." Unless local conditions forbid, the alternating-current motor for factory work is the two- or three-phase type, and these have characteristics similar to the shunt-wound direct-current motor. The brush type is preferable for motors of large size where it is desirable, on account of the dynamos and lights or for other reasons, to keep the first inrush of current on starting down to a small amount. This type is not quite as simple as the brushless type, and for small motors (up to 10 horse power), it is rarely used. The brushless type is used for large sizes as well as small, and for shop work and dirty places where the flickering of lights is unimportant, and where the generator and transformer capacity is ample, this type is preferred.

Motors may be designed for any speed, but the lower the speed the higher the cost, as the capacity of a motor for a given size varies almost directly as the speed .

EDITORIAL COMMENT

THE whole trend of modern works management, on the physical side, is toward increase of output as a means of cost reduction. The fact kept constantly in view in running the power plant and the machinery is that fixed charges remain unchanged through a wide range of difference in volume of manufactures, and hence become proportionately small as that volume rises. If, for example, the cost of general management, rent, interest, taxes, insurance, lighting and heating, power, etc., amount to $50,000 a year for an output of 100 machines, each machine must bear a burden of $500 as its share of general expense, over and above the labor-and-material cost. If, however, the same plant can be speeded up to an output of 200 machines, this general-expense burden on each one drops to $250. It can be sold at the same price as before with $250 more direct profit to the maker, or it can be sold for $250 less with the same direct profit as before, and with a great indirect advantage in enlarging the possible market and in meeting competitors. Hence the strenuous and striking efforts to increase production by study of machine processes, the use of high-speed tools, electric driving, multiple setting tables, and all the other devices of the "modernizing engineer."

* * *

ALL this seems so obvious that the statement of the principle even is superfluous—until we turn from the physical to the human side of the manufacturing problem, and find there that the whole scheme of production is subject to constant, wasteful, and brutal interruption because of the inability of the two elements—employer and employees, motive power and moving parts—to work in any kind of harmony, or to adjust their differences by any means save the archaic one of coming to a complete standstill. The utmost refinements of skill are put upon the machinery, that minutes may be saved; the whole plant is shut down in idleness for weeks, while a strike or lockout drags itself to an often wholly inconclusive settlement. Meantime the public suffers perhaps all manner of inconvenience, and the idle time, with all its unused potentialities of productive effort, is wasted for ever. There is something wrong with the industrial philosophy which is so marvellously effective on the mechanical side and so complete a failure in dealing with the workman.

It would be foolish as well as futile to dream that these conditions can be suddenly bettered. No argument to the intellect can gain at once a controlling power over a vast body of men, sufficient to silence the promptings of impulse, the ingrained prejudice of class, or the demands of apparent immediate personal interest. It did not comfort the individual hand-weaver whose employer was installing machinery to know that the power loom, which he was too old to learn to run, would eventually employ a hundred of his class where formerly one had worked. All that he could see was his own prospect of immediate starvation. No economic argument about the ultimate good of the race would feed his family, or deter him from the hopeless attempt to oppose fate by smashing the new machinery, if he could. And no demonstration of the economic basis of trade-unionism will be kindly received by the employer whose men have been led out in an unreasonable strike, or whose works have been fired by labor rioters. There is no panacea but common-sense, reason, and justice. Common-sense is unfortunately rare, and the world's most inspired moral teachers have been preaching reason and justice for several thousand years, without converting the hearts of more than a very small discipleship.

* * *

THERE are, however, certain truths so apparent that they ought to be tacitly accepted by both sides ; and being so accepted, they should greatly widen the ground over which there should be permanent peace between capital and labor, and greatly temper also the bitterness of the struggle on outlying points.

Foremost is the fact that organized labor is an inevitable outgrowth of modern conditions of manufacturing. It is a primordial instinct for those who have common interests and dangers to make common cause—an instinct older than the swarming of the bees or the herding of the wild horses. And the factory system first facilitated the formation of the union by bringing the great company of workers together in the closest personal contact, next held up to them the example of successful organization in its corporate ownership and management, and finally supplied the imperative motive by accentuating the frequency, the suddenness, and the weight of those economic shocks to which the wage-worker—the least able to bear sudden deprivation of income—has unfortunately always been most exposed. The first trade-unionism was the only resort of workingmen who found themselves confronted with the conditions of the early "factory era," and like most expedients under desperate conditions, it was itself desperate. It was blindly selfish, because the model set for it was so. As it gained power, it was—or attempted to be—hideously and impossibly arbitrary, because employers had been arbitrary. If from the outset, employers, because they were stronger and farther-seeing, had felt it incumbent to shield their employees so far as possible from the shocks of economic changes, trade unions might have been conceived in a different spirit and might now have been giving their attention to wise and useful things, instead of the often senseless and exasperating wrangles in which they waste the energy and substance of their members and the world at large. But much of the present trouble comes from the fact that the selfishness of the early workmasters is recoiling upon the heads of the present generation. Secure in their wealth and influence, protected by the ability to insure their property, to mobilize their capital and divert it from decadent to prosperous lines, to control legislation and hedge themselves in with tariffs or bolster themselves with subsidies, they were indifferent to the plight of the laborer, naked to the storm of adverse conditions and changes. The worst examples of this indifference probably were furnished by the manufacturers of Lancashire and Yorkshire in the early nineteenth century—but are we in a position to condemn ? Here are the words of Grover Cleveland, written in the White House in 1887 :—

> "The discontent of the employed is due, in a large degree, to the grasping and heedless exactions of employers.
>
> "Those who toil for daily wages are beginning to understand that capital, though sometimes vaunting its importance and clamoring for the protection

> and favor of the Government, is dull and sluggish until, touched by the magical hand of labor, it springs into activity. And the laboring man is thoughtfully inquiring whether, in these circumstances and considering the tribute he constantly pays into the public treasury as he supplies his daily wants, he receives his fair share of advantage. . . . The gulf between employers and employed is constantly widening, and classes are rapidly forming, one comprising the very rich and powerful, while in another are found the toiling poor. As we view the achievements of aggregated capital we discover the existence of Trusts, combinations, and monopolies, while the citizen is struggling far in the rear, or is trampled to death under an iron heel."

The unions can not be suppressed; but their false economic theories can and must be exploded, their false leaders retired, their false aims corrected, their false pretensions curbed. Some of these operations will be severe, and only to be administered by an organization of employers as strong, as coherent, as devoted to their cause as the rank and file of the labor unions, but far wiser in their purposes and absolutely just in their aims and acts. It is common to condemn the unionist for his unhesitating obedience to his cause; but it must be remembered that the attitude of most employers has been that of open warfare against the union, or at best an armed truce with it. The unionist feels himself an industrial soldier, constantly in face of the enemy—and is there anywhere a more complete surrender of personal liberty than in the case of the soldier, who takes the life of others, or lays down his own, at the command of his superior?

Enlightened unionism is no more necessarily selfish and arbitrary than enlightened corporate management. It rests largely with employers, who, whatever their failings, have had the courage and foresight to carry the factory system to triumphant economic success, to turn this union movement also to enlightened and profoundly useful ends. For it can no more be "smashed" than the use of machinery, or the whole system which developed from the use of machinery, could be smashed. Here and there a union may be broken, as here and there a factory was burned and its machinery destroyed; but the union will organize again, just as the factory was rebuilt. It is as logical, as reasonable, and as inevitable that labor should organize as that capital should organize, and those who seek to destroy the unions are as misguided friends to employers at large as the early labor leaders were to workingmen at large. Without the slightest sympathy for most of the demands put forth by union labor, or for most of the methods by which it seeks to reach its ends, but with the profoundest devotion to the cause of productive industry as represented by the manufacturer, we urge the recognition of union labor as a necessary development, and the concentration of effort upon its diversion into and confinement within its proper bounds.

* * *

The solution, we believe most emphatically, will be found in the raising of the moral and intellectual tone of the unions by the entry of a better class of men—a sane, reasonable, and conservative element—so that, with labor represented by a tangible and responsible organization on the one side, and capital represented in like manner on the other, differences may be settled on a sound and equitable basis by conference, mutual explanation, and, if necessary, arbitration.

And this result will be secured, not by antagonizing the union, but by encouraging the better men to join it, and thus, by numbers and force of influence, retiring the demagogue and agitator into an impotent minority. It is not the policy of Mr. Parry, but that of Mr. Mellen, which offers the hope of the future. The open shop—emphatically, yes! But open in the freest sense, and in the spirit defined by Mr. Mellen, quoted in our last number, and now repeated as giving, in our opinion, the definition of an ideal attitude for the employer. No manufacturer need hesitate to place himself upon the same platform with so large an employer of labor as the president of the New York, New Haven & Hartford Railroad:—

> "I am going to surprise you by saying that I regard the unions as a condition that has come to stay; that I have no prejudice whatever to properly-conducted ones, and express my wish that our men generally would join them, not that I would run a union plant as such, for I would not coerce my men nor consent to discriminations as between those who were and who were not members, but I would wish to have in the unions the conservative influence of many of the good men who are out, to counteract the floater, the anarchist, the man who has nothing at stake in the world, who works with his mouth more than his hands.
>
> "My advice to you who have families, who have a stake in the world, is to join your unions, and make yourselves felt in them. Be always a force for conservatism. It seems to me as much in your interest to do this as that you shall attend the caucus and nominate good men for office and vote for them at the polls. Your apathy is the opportunity of the demagogue, the anarchist, the floater, who has nothing to lose."

Unquestionably, there are cases and localities where drastic purgative treatment is needed before the unions are healthy enough to be received into any kind of industrial fellowship. But it is not impossible that the attitude of fixed opposition to organized labor heretofore generally maintained by employers has given the union its chief charm to a turbulent, lawless element always perversely disposed to be "against the government, whatever it is." The relaxing of that opposition on the part of employers may cause the union to gain quality by a double process—by making it more congenial to the conscientious workman who is naturally disposed to harmony with his employer, and by removing the attraction of opposition which now draws to it the agitator whose instinctive delight is in discord.

It is certain, at all events, that the present conditions hold more of menace to our national prosperity—even our national stability—than anything else within the political and economic horizon. On grounds of high expediency, therefore, as well as industrial economy, is it not well worth trying some radical modification of the policy under which these conditions have developed and under which there is no hopeful sign they can ever be ameliorated?

* * *

It is probably unnecessary to give serious attention to the frothings of certain Chicago papers, which have been demanding that all studies for the Panama Canal be taken up again *de novo*, so that a wholly "American" solution may be had. The years of supremely able and almost priceless study and investigation expended upon the work by the Nouvelle Compagnie—study of which the essential data and results have been summarized in these pages by General Abbot—these could not be replaced except by the expenditure of twenty-years time and untold millions of dollars by the American commission. And to be consistent, the Chicago movement should not stop there. This new Know-nothingism which would use only the domestic brand of research and investigation must reject much more than the conclusions of the Nouvelle Compagnie. It must throw overboard Bessemer, Stephenson, Watt, Newton, Copernicus—and what of Christopher Columbus? Shall Chicago accept anything discovered by one who was not an American? Never! Let the discovery be made over again, under Chicago auspices.

* * *

To the same order belong, it is to be hoped, the rumors that some members of the commission are favoring a sea-level plan with a dam at Gamboa and a tunnel to the Pacific. It is scarcely credible that engineers of standing should engage in futile consideration of a scheme which has neither novelty nor good sense to commend it. This project was one of the earliest to be considered by the engineers of the Compagnie, and one of the most promptly discarded on account of its manifest inexpedience. The sea-level canal at Panama is a possibility of the future, but of the future only. Any attempt at it now (or at any time by any tunnel scheme) would be wasteful to the point of disaster. The only really good solution will be found by following the general features of the project adopted by the Nouvelle Compagnie, perhaps as modified and adopted by the Isthmian Canal Commission. The former has been admirably supported by General Abbot, in several contributions to this Magazine, while the latter was advocated with equal vigor, in our issues for January and June, 1903, by the late George S. Morison, whose loss is more and more regretted as the importance his talent and force might play in the completion of the work become more apparent.

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BUT even in his most emphatic argument for the high-level plan, as distinguished from the low-level lock plan of which General Abbot is the leading advocate, Mr. Morison admitted that a second lake, retained behind a dam at Alhajuela, would be "the most economical and satisfactory method of storing the reserve water which will be required," to say nothing of its value in bettering the navigation of the canal by absolutely controlling the upper Chagres. Now it is suggested by one of the highest authorities in the United States that there would be enormous advantage to the work of building the canal if this dam were built *at first*, instead of as a supplementary undertaking. The Chagres River would thus be made, from the start, the most useful agency in the construction work. The great water power made available at the dam could be developed by turbines and electrically transmitted for use at any point along the line. It would particularly facilitate the transfer to the dumps of the spoil from the Culebra cut. And as the installation would be needed later for the operation of the canal, it would be money doubly well invested.

* * *

ALTHOUGH the work of the Panama Canal Commission has not yet appeared before the public in any very conspicuous manner, it is interesting to note that very important progress has been made in the fundamental operations upon which the success of the whole undertaking must rest. Probably no actual construction work will be begun before July of next year, but in the meantime plans for the sanitation of the entire zone have been formulated, and these are now being actively pushed. When it is understood that there are about two-thousand buildings of all sorts included in the property acquired from the French Company, as well as all the towns and villages along the route and within the canal zone, that all need to be overhauled, sterilized, and made healthful, and that a complete supply of pure water is to be provided along the route, it will be seen that there is plenty of work to be done before the actual excavation is started. For all this work the control and operation of the Panama Railroad becomes invaluable, and its possession greatly simplifies the work of the commission.

REVIEW OF THE ENGINEERING PRESS.

"THE WORLD IS ITS FIELD"

WINDING PLANTS FOR GREAT DEPTHS.

PROBLEMS OF INERTIA, ACCELERATION, CONSTRUCTION AND OPERATION IN CONNECTION WITH DEEP MINING WORK

Hans C. Behr—Institution of Mining and Metallurgy.

ONE of the natural tendencies of the adoption of modern rapid methods of mining is seen in the rapid exhaustion of levels and veins of ore, so that it becomes constantly necessary to deepen existing mines to give access to fresh strata. Thus depths of nearly 5,000 feet have already been reached in several mines, and methods of operating at still greater depths, such as 6,000 to 8,000 feet below the surface will doubtless soon have to be considered.

For these reasons the paper of Mr. Hans C. Behr, presented before both the Institution of Mining and Metallurgy, in London, and the South African Association of Engineers, at Johannesburg, is of much importance, dealing as it does with the important problems connected with the hoisting of ore and materials from these great depths. The paper was discussed *in extenso*, both in London and at Johannesburg, and the whole forms practically a treatise in two portly volumes, rather than the ordinary example of a professional paper.

The principal question connected with deep mining lies in the construction and operation of the hoisting machinery, and the great problem to be solved in this matter is the management of the ropes. In lifting materials from a small depth the weight of the rope is insignificant in comparison with that of the load to be raised. When, however, the depth is increased the weight of the rope becomes proportionally greater, besides being a variable quantity, a great length and weight of rope forming the load when the cage or skip is at the bottom of the shaft, and this length and weight diminishing to nearly zero when the top of the shaft is reached. It is obvious, therefore, that with very deep shafts the use of a single lift, with rope of uniform diameter, wound upon a cylindrical drum, an arrangement answering very well for moderate lifts, will throw a very great and irregular load upon the winding engines.

The importance of considering the weight of the rope in deep mine hoists will be seen from the fact that modern wire ropes, with a breaking strength of 120 tons per square inch, have their safe load reached by the weight of the rope alone with a length of about 8,000 feet, taking a factor of safety of 7, so that at such a depth the entire strength of the rope would be required to sustain itself regardless of any useful load to be hoisted. If a factor of safety of 5 be permitted, the maximum length of rope is 11,400 feet, so that the possibilities in this direction may be seen to be very limited.

When the depth of the mine is entirely within the possibilities of single long hoists the feature to which much attention is devoted is the equalization of the load upon the winding engines. As has already been noted, the load due to the rope is continually varying, being a maximum when the cage is at the bottom, and diminishing as the top is approached. Various methods have been proposed and used to equalize this load. The most complete is the use of a tail rope; this making the load constant at all points, and equal to the maximum.

Another plan is to employ taper ropes, since there is much less load upon the lower part of the rope than on the upper portion. The variable load upon the engine may also be partially equalized by the use of conical winding drums, the radius, and hence the leverage changing according to the load, much in the manner in which the old chain and fusee movement was used in watches. The taper rope has the especial advantage that much of the weight of the rope is saved, since a rope of uniform diameter must necessarily be of the diameter sufficient to sustain the maximum load, and therefore much heavier than is needed at the lower end.

Mr. Behr examines all the operative conditions and derives mathematical formulas for practical use, giving also examples of the applications of these to specific cases. In general his conclusions were that for depths of 6,000 to 8,000 feet the hoisting should be done in two stages, preferably by two separate engines on the surface; single-stage winding being recommended only for depths of less than 4,500 feet. He emphasized the desirability of using taper ropes, and for this reason he did not advocate systems such as the Koepe or Whiting, in which the rope is passed a few times around a winding drum and then over an idler. These latter methods, when operated in connection with tail ropes, give very good results for depths within the convenient limits of cylindrical ropes, but their use prevents the employment of taper ropes. The winding engines with conical drums are considered the most advantageous, but Mr. Behr considers desirable even smaller end diameters than are now customary.

The general trend of the discussion naturally led to the consideration of the ropes. It is possible that improvements in materials may provide ropes of greater strength and less weight than are now available, but there must naturally be a limit in this direction, and the cost limit as well as the strength limit must be considered. The winding engines also came in for a share of the discussion, but the most interesting part of the matter lay in the remarks of a few of the more independent and less conservative men, who realized that the best prospect for advance must lie in the adoption of some other method of hoisting than that which makes the greater part of the load not only useless but troublesome. If the greater part of the power and expense in deep-mine hoisting comes from the ropes, the sooner the ropes are done away with the better. So far as the question of the transmission of power is concerned, the cable has long since been superseded by the electric conductor in other places, and for horizontal traction, in the case of tramways the nuisance of the cable has been most successfully abolished. Naturally vertical traction is a more difficult problem than horizontal, but it certainly appears that the difficulties to be overcome with vertical electric traction are fewer than those which are seen to exist with rope hoists and winding machinery.

The true solution of the problem of getting valuable material from great depths lies in the placing of the motive power upon the cage, and dispensing altogether with the hoisting rope. An electric motor could be used, as was suggested by Mr. Ashmore, to operate gearing meshing into vertical racks, exactly as the engines on rack mountain railways are worked. The difference between the mountain railway and such a hoist is mainly one of grade, the mine hoist usually having a grade of 100 per cent., or rather more than double that of the steepest mountain roads. Mr. Ashmore also suggests that the energy of the descending cage could be recovered electrically, and indeed the only immediate objection to this plan appears to be that it would be slow. It is by no means certain that a good speed might not be attained with such a system, especially if the details were worked out by engineers having experience with the possibilities of such machinery, and not hampered by the burden of mining precedents. It is certain that a much greater proportion of the energy supplied would be recovered in useful work, and the larger loads carried might make up in great measure for the slower speed of movement, so that the rate of delivery of material is the question to be considered rather than the linear speed.

The real question settles down to one of cost, and if the material to be raised is of sufficient value to warrant the expense of devising and constructing machinery to get it out we may be well assured that hoisting machinery will be forthcoming to operate at any depth at which men can be employed.

SMOKE PREVENTION.

CAUSES OF THE PRODUCTION OF SMOKE IN STEAM-BOILER FURNACES AND METHODS OF MINIMIZING THE SMOKE NUISANCE.

R. S. Hale—Mutual Boiler Insurance Company.

EVER since the introduction of steam power the smoke nuisance has been with us, and it is a matter of record that some of the most earnest work of James Watt was expended upon the invention of improvements in furnaces to prevent the production of smoke. Although many papers have been written upon the subject, by far the greater part of them have been prepared for the purpose of advocating, either openly or covertly, some special method of smoke prevention, and for this reason the admirable paper recently issued from the pen of Mr. R. S. Hale demands notice, since it is entirely free from any such motive.

Mr. Hale first examines the subject of mechanical stokers, and shows that from a study of a carefully selected set of tests, omitting any data which were in any way open to suspicion, it appears that there is little or no economy to be obtained from the use of mechanical firing. Stokers should therefore be considered upon their merits as devices for the prevention of smoke, and extravagant claims as to fuel economy from their use may be discounted.

The proper way to prevent the production of smoke is naturally to burn smokeless fuel. Anthracite coal makes no smoke, neither does coke, but these are not always to be had. New York, for example, is in the fortunate position of being able to employ anthracite for nearly all purposes, and when the supply of this fuel was interrupted, as during the recent coal strike, the difference in the appearance of the atmosphere was at once apparent.

"When hard coal or coke can be used the problem is solved. If soft coal which contains hydrocarbons must be used, it is impossible to prevent the smoke nuisance entirely. Soft coal, it is true, can be burned so as to give no visible smoke at the chimney-top, and it is likewise true that an oil lamp or gas jet can be burned so as to give no apparent smoke. Nevertheless, those who use electric light know how much cleaner their walls and ceilings remain than when they used gas or oil, while the discolored ceilings over a gas jet or oil lamp show where the soot comes from. I have had instances, in my practice, of serious complaint from soot in the neighborhood of a soft-coal furnace, though even the complainants admitted that practically no visible smoke came out of the chimney.

"This leads us to one very important consideration, and that is the fact that it is the actual quantity or weight of soot discharged into the air that causes trouble, while it is always the appearance of the chimney top that causes complaint. For instance, consider a furnace that gave dense black smoke for ten minutes each morning and each afternoon, or say twenty minutes in each twenty-four hours or 1/72 of the time. If we compare such a chimney with one that gave only 1/10 as much smoke at any particular moment but gave steadily some light smoke, the latter would cause much less verbal complaint to the smoke inspectors, especially under such ordinances as are now on the statute books, but would really be giving about six times as much soot.

"We may also compare a battery of boilers each with its own chimney as against the same boilers delivering into a common chimney. If a single one of these boilers smoked very badly and the others not at all, then with individual chimneys there would be much complaint, while with a single large chimney for the battery the top would show only a light smoke which would cause but slight complaint although the amount of soot would be the same.

"Another point that should be carefully considered, but that is not always considered, is the question of central power stations. The electric light and power companies are in large cities almost universally spoken of as the worst offenders against the smoke laws, but a brief consideration will show that we could afford to let them send forth almost any amount of smoke rather than put any serious burden on them. The choice whether a small factory or an office building shall put in its own plant to make its own light and power, or, on the other hand, buy electricity from the central station, is a close one, but the central station runs on a 2 pounds coal per horse power while the isolated plant seldom gets under 6 pounds per horse power. Hence, for the same amount of soot given forth into the atmosphere, the central station should be allowed to make three times as much smoke.

"Another point that is not often considered, in fact, that cannot be considered, is that the amount of soot is not proportional to the color of the smoke. A small chimney attached to a boiler that is using but a small excess of air may show a dense black smoke. Change this over to a large chimney and let a large amount of air into the flue at the base of the chimney. Then the color of the smoke at the top will be much lighter though the amount of soot may be the same as before."

The formation of smoke in the furnace, as Mr. Hale points out, is due to the dissociation, or "cracking" of certain of the hydrocarbon compounds formed during the distillation of the coal, the smoke not being one of the original constituents of the fuel, but formed by the separation of such compounds as paraffine into the lighter colorless hydrocarbon gases and the heavier sooty residue. To get rid of this soot requires the presence and intimate contact with oxygen at a sufficiently high temperature.

"If, while the temperature is high enough, enough oxygen is supplied and properly mixed with the hydrocarbon, the maximum amount of the hydrocarbons will be burned and the minimum amount of soot formed. Any failure to give the highest possible temperature, to give sufficient oxygen or to mix the hydrocarbons with the oxygen at this temperature will increase the soot. The harm done by *extra* oxygen may here be briefly referred to. If extra oxygen be supplied that does not burn, then the temperature of combustion and of the gases above the fire is seriously reduced. This immediately reduces the rate of transfer of heat from the gases to the heating surface, while, at the same time, the length of time that any particular pound of gas remains in contact with the heating surface is also reduced by the same serious amount, since a greater quantity of gas passes over the heating surface in the same time. The less time offered for transfer of heat and the lessened rate of transfer of heat, both operate to reduce the amount of heat taken up by the heating surface, so that the quantity of heat lost by the heat of the waste gases in the chimney is greatly increased. As this already is the most serious loss (amounting usually to two-thirds of the total waste of heat in making steam), any increase in its amount is a very serious matter."

In addition to the presence of the proper amount of oxygen and the maintenance of the proper temperature, the time element must be taken into account.

"The question of mixture of the air with the hydrocarbons is seen to be very important when we figure the time allowed. A rate of combustion of 20 pounds coal per square foot per hour is not unusual. This makes roughly about 20 pounds gas per pound coal, or 400 pounds gas. At ordinary temperature, say 60 F. or 500 absolute, this makes about 13 cubic feet per pound, while at combustion temperature of, say 2,000 C., this is about 100 feet per pound of gas, making a total of 40,000 cubic feet per square foot per hour, or 11 feet per second. In some forms of water-tube boiler the gases have but three feet or so of travel before they enter the tube nest, or the time for mixture and ignition is but 1/3 of a second. By providing a large combustion chamber, as may be done, for instance, in a horizontal tubular boiler, this length of time may easily be increased four times. It is impossible to do more than estimate this average time. In a horizontal tubular boiler, for instance, some of the gases undoubtedly travel the whole length of the boiler. Others travel only the vertical distance from the grates to the shell, but if they then deflect they may mix with other gases hot enough to keep up the temperature to the proper point and have a longer time for ignition."

Mr. Hale cites a case in which, with two batteries of boilers, otherwise identical, one set has the shell set two feet above the grates and the other four feet, with the result of a greatly lessened smoke production by the latter arrangement, doubtless due to the increased combustion space.

"The advantages of a brick combustion chamber or brick arch in maintaining the temperature are very obvious. On the other hand, such construction, especially the arch construction, needs frequent repairs, and some designs of brick combustion chambers, such as checkerwork, check the draft and reduce the capacity and need frequent cleaning from ashes.

Another method of maintaining the temperature is the down-draft principle, whether in the Hawley type or in the underfeed stoker. These supply the coal where the fire is coolest instead of where the fire is hottest, and force the gases as distilled from coal when first heated to pass through the hot fire. The effect obviously must be good.

"The cost of these is high both for installation and repairs, and it must be remembered that the apparent cost of repairs is not the only cost. Repairs involve laying off the boiler, and the fixed charges such as interest and taxes all go on whether boiler is used or not; in addition to this the use of any apparatus subject to repairs involves keeping extra plant ready in case of accident that may happen unexpectedly to a minor part and cause the laying off of the boiler. Any such apparatus further requires more supervision on the part of the superintendent or manager. A much larger proportion of the time of the superintendent will be found to be devoted to the power plant when any special apparatus is employed."

All of the above methods are considered by Mr. Hale as tending to reduce the production of smoke, although he admits that complete prevention is impracticable.

"Short of the use of hard coal or coke, smoke cannot be entirely prevented. In a manufacturing district dependent upon the production of cheap power for its very existence, it is probably unwise to put any limit on the production of smoke. Any such restriction will increase the costs of manufacturing, and the reformers, while they may reduce the smoke nuisance, will find they have checked the development of the very basis of existence of the town.

"In districts partly residential, partly manufacturing, it is a question of judgment. Some restriction on smoke production is probably wise. Complete restriction is undoubtedly unwise unless it is practicable to force the use of hard coal."

THE SURFACE HARDENING OF STEEL.

A STUDY OF THE PROCESSES OF CEMENTATION AS APPLIED TO CARBON STEEL AND TO SPECIAL STEELS.

Léon Guillet—Société des Ingénieurs Civils de France.

THE process of cementation is one of the oldest in the metallurgy of iron and steel, since the original method of producing steel was that of heating iron in contact with carbon until a partial combination took place, the product being afterwards made homogeneous by remelting in crucibles. The ordinary operation of case-hardening is also a cementation process, and this, in various modified forms, is yet most important, being employed alike for the improvement of the small parts of modern automobiles, and equally for the perfection of the massive pieces of armor plate of the latest types.

In a paper recently communicated to the Société des Ingénieurs Civils de France, by M. Léon Guillet, the manner in which the operation of cementation, or surface carbonizing of steel, is effected is discussed at length, making use of the methods of metallography, or the miscroscopic study of the structure of the metal under various conditions.

Until recently the operation of cementation was one concerning which but little was known, from a scientific point of view, nearly all the practical work being performed according to empirical methods, acquired by experience, and often jealously guarded as valuable trade secrets. M. Guillet has shown that the process is one entirely capable of reduction to scientific and rational system, and examines its details in a most interesting and valuable manner.

The object of cementation is the production of a piece which shall be tough and resistent in the interior, while the exterior surface is given a certain degree of hardness, suitable to stand wear or abrasion, and capable of receiving a finish possessing a low coefficient of friction. In order to produce this result the article is made of mild steel and then surrounded with carbon and subjected to a temperature sufficiently high to cause the carbon to dissolve in the iron. This gives a piece with a surface rich in carbon, while the interior remains unchanged, and a subsequent tempering permits the production of a surface of any degree of hardness desired. It thus appears that the operation of cementation is really one of dissolving carbon in a solvent of iron or mild steel.

This operation appears to be a very simple one, but investigations in the light of modern theories show it to be really very complex. Osmond has shown that iron can dissolve carbon only when the former is in what is called the *gamma* state, and that iron in either the *alpha* or *beta* states is incapable of dissolving carbon. For this reason it is necessary that the iron should be raised to a temperature of 800° C. before the operation of cementation begins. If the operation is conducted at the temperature at which the change from the *beta* to the *gamma* state begins there will be formed simply a layer of cementite, without any true solution of the carbon in the iron. The extent of the solution also depends upon the amount of carbon already contained in the steel, as well as the nature of the carbonizing material employed. In general, there are four factors to be considered in the operation: The nature of the steel; the nature of the cementing material; the temperature at which the operation is conducted, and the time during which the contact is maintained. It has been maintained by some that there are steels which are incapable of cementation, but M. Guillet maintains that this is incorrect so far as carbon steels are concerned, although it is true for certain special alloy steels.

By employing the methods of microscopic metallography M. Guillet has made some valuable studies as to the influence of variations in temperature, time, and material upon the effects produced, including the depth of the carbonizing, the time required for penetration, and the distribution of the carbon. These results are best exhibited to the eye by photography, and a number of microphotographs are reproduced in the original paper. In general it appears that there is no variation in the time required for the penetration for steels having an original carbon content of 0.51 per cent. or less, while for steels of higher carbon content rather discordant results were obtained. The time of penetration seems to depend upon the temperature, this appearing very clearly in the photographs. The influence of the cementing material is also to be considered, but it is impossible to lay down any precise points in that respect, owing to the wide variation in materials, and it becomes necessary to determine the action of each substance by experiment.

In general the cementing materials may be divided into three classes: those acting by the formation of carbonic oxide; those acting by means of a cyanide; and those employing hydrocarbons. Experiments made with pure carbon in a vacuum have demonstrated that no cementing action takes place; it is necessary that air be present and that carbonic oxide is formed. In the case of the cyanides there is a decomposition in which the carbon is liberated to be dissolved in the steel, while when hydrocarbons are employed, in the form of illuminating gas, petroleum vapor, etc., the carbon is released by dissociation. In general M. Guillet gives rules to be employed in practical operations. Steel of 100 to 150 carbon should be used. The cementing material should have a definite chemical composition, such as a mixture of 60 parts of carbon and 40 parts barium carbonate. The operation should be conducted at a temperature of 800° to 850° C., the temperature being maintained as nearly uniform as possible. It is desirable that there should be sufficient cementing material at all points around the piece, and a thickness of at least 5 centimetres of the carbonizing cement should be provided. The cemented piece should be allowed to cool and then placed in a furnace having a temperature of about 800° C., and allowed to become uniformly heated, after which it should be quenched.

M. Guillet illustrates a number of designs for furnaces to be used for cementing work, and discusses various practical points, in connection with the regulation of temperature, handling of material, and other details.

The cementation of special alloy-steels is also discussed in the paper of M. Guillet, but the extent of this field renders it impossible to do more than touch upon it. The best results have been attained with a nickel steel, containing about 2 per cent. of nickel and 0.20 carbon. Such a steel is much more readily cemented than an ordinary carbon steel, and it should be quenched at a lower temperature, about 750° C. Data are also given concerning experiments with manganese, chrome, tungsten, and molybdenum steel, but further investigations with these are desirable.

The paper of M. Guillet, of which we have been able to give here but a brief abstract, is a most important contribution to the subject of workshop metallurgy, and it shows conclusively the manner in which rational and scientific methods may well replace the older empirical manner of conducting such important operations.

APPRAISALS OF COAL LANDS.

APPLICATIONS OF SCIENTIFIC PRINCIPLES TO THE DETERMINATION OF THE VALUE OF MINERAL PROPERTIES.

H. M. Chance—American Institute of Mining Engineers.

ONE of the ways in which the work of the engineer is becoming of growing importance in the commercial world is found in the manner in which he is called upon to determine the real values of things. The financier may be an adept at the effecting of combinations, and capitalizing existing values at figures based upon the trade conditions involved, but he must know something about the real value of the thing he is handling, and for this information he is learning to turn to the engineer. An excellent example of this department of engineering is seen in the paper of Mr. H. M. Chance, presented before the American Institute of Mining Engineers, upon the subject of the appraisal of the value of mineral land, with especial reference to coal lands. In introducing the subject Mr. Chance refers to this phase of the matter.

"In no field of productive industry have the economic results attainable by consolidation been more clearly shown than in the mining regions of the United States. In many important mining centers unification of ownership of the most valuable properties has already partially or completely been attained, and in other districts projected absorptions and consolidations await only favorable financial conditions for their consummation. The iron-ore districts of the Lake Superior region, the coal-mines of Colorado, of Wyoming and of Utah, the anthracite mines of Pennsylvania, the Connellsville coking-coal mines, and large areas of bituminous coal-land in Pennsylvania, in Ohio, in the Indian Territory and in other portions of the United States, are now largely controlled by a few corporations operating on a large scale, or by a number of corporations working in harmony because of an affiliation and interleaving of interests.

"The tact of keen financiers and the diplomacy of men of great administrative ability are the chief operative forces in conceiving and accomplishing such consolidations, but in formulating and maturing them, the services of the mining engineer are often required to supply the facts upon which they must be based. For this purpose the expert is expected to furnish full and complete reports covering the quantity of ore, coal or other mineral available, its value per ton, cost of mining and treatment, etc."

It is evident that this kind of work requiries something more than a knowledge of the mere mining questions involved, since it includes also a familiarity with the economic conditions affecting the cost of production and transportation, the element of competition, and the market possibilities, broadening the work of the engineer into that of the man of business affairs.

The older methods of estimating the value of mineral lands were based upon the values which had been expended upon it, or upon the prices realized by other sales in the vicinity, but these are recognized as of limited usefulness. A more scientific method, used by Mr. Joseph S. Harris, has also been employed.

"By this method the total workable coal in the ground is first determined, and valued at a certain sum per ton, this estimate being based either upon what the coal would produce if leased upon a royalty, or upon the profits of mining it. Using as a basis the rate of increase in production, as shown by past experience, the probable yearly increase of output is calculated, and from these figures the probable revenue is calculated for each year of the period during which the assumed output can be maintained, or until all the coal is mined. Then the probable future earnings of the land, either by royalty or through operation, are capitalized at their present money value, by the usual formulas for deferred payments, at a certain assumed rate of discount."

Other methods include the assumption of the operation of the property at a certain yearly output for a fixed number of years, or of the use of the actual net earnings as a basis, limited by the appraised value of the land, plant and improvements, as reached by other methods.

"While it is unwise to appraise at a high valuation the good-will of a purely commercial business, the value of a manufacturing industry producing staple products includes, as one of its most important factors, the established reputation of its products, its facilities for selling and distributing its output and the conections and friendly affiliations with consumers, dealers and transporting agencies that enable it successfully to retain its grasp upon the trade, to extend its operations and to expand and enlarge its business. In other words, an industry of this character can only be valued at its true worth by taking as a whole its property, plant, improvements, reputation of its products, its established trade, selling facilities and connections. Proper investigation having shown that the output of the concerns can be maintained for a long period, even at a rate of production in excess of present shipments, its value as a business proposition may be safely appraised, and in so doing it is customary to assume that the business, including plant and property, is reasonably worth a sum upon which the yearly net earnings will pay a satisfactory return.

"In order to confirm the valuation determined by this method, separate appraisals in detail should be made showing the value of the lands, plant and improvements."

Taking up in detail the valuation of coal lands, Mr. Chance shows that the engineer should familiarize himself with the quality and quantity of coal available, the thickness of the workable beds, the cost of mining and transportation, the mining conditions presented by the district, the character of the improvements required, and other conditions affecting the industry as a whole in the region under consideration. Some of the points naturally suggest themselves, but all are important.

The quality and quantity of the coal form the basis of the whole investigation, since these cover saleable material from which revenue is to be gained. The other points are mainly concerned with the charges against this productive element. Thus the cost of mining should be considered in comparison with the average in the district in which the property is located, while transportation forms a most important element in determining market values.

Mr. Chance plainly remarks that coal land so located that it cannot be reached by railroad at reasonable cost, or owned by persons not commanding sufficient capital or influence to secure the building of a railroad, is of small value.

The question of ownership is of much importance, and a mere change of ownership may affect the value in either direction very materially.

"If the coal is owned by those able to mine it quickly, the value is greater; if it is to remain untouched for a long period, or to be worked on a small scale, the value is less. The concentration of large holdings into one corporation increases the value of the whole as a unit to a sum far greater than the sum of the values of the individual tracts, because a corporation can establish selling-agencies at all important distributing and consuming centers; can spend large sums for advertising; can form close affiliations with manufacturing and transportation companies; can retain able counsel and employ the best managers and representatives that can be found; can own its cars and can make whatever outlay may be necessary to build up a large and permanent business."

Mining conditions, which naturally belong specifically in the domain of the engineer, are classified as belonging to the actual cost of working; the possibility of planning large development with improvements of permanent nature; of output possible from each operation; and upon the capital required for the plant and its development.

In general the valuation of a mining property should be based upon the logical method of taking all the technical and commercial conditions into account and summing these up in proportion to their weight in the special case under consideration. No close rules can be given, but Mr. Chance has laid out the general principles in such a systematic manner that they can be applied to almost any case which can appear in practice, thus removing the work from the domain of guesswork and placing it in the category of scientific investigation.

HIGH-PRESSURE CENTRIFUGAL PUMPS.

APPLICATIONS OF HIGH ROTATIVE SPEEDS AND SERIES-CONNECTION TO THE CENTRIFUGAL PRINCIPLE FOR PUMPING.

Messrs. K. Sosnowski, Julius Divis, and H. Dubbel.

CENTRIFUGAL pumps have been employed for many years, and for the elevation of large volumes of water to moderate heights they have been found most satisfactory. The freedom from shock, the absence of valves or reciprocating parts, and the simplicity of construction have rendered the centrifugal principle a very useful one for moving liquids. It has been recognized for a number of years that an increase of rotative speed would enable centrifugal pumps to deliver liquids at greater elevations than is customary with such machines, and the principle of operating several centrifugal discs in series, each delivering the water to the next has also been found a practical method of increasing the height against which such pumps could be worked. These methods have been brought into practical service of late, mainly because of the rapid introduction of motors of higher rotative speeds. Electric motors may be designed to run at high speeds very effectively, while the development of the steam turbine has exerted a material influence in drawing attention to machines capable of direct connection to them.

Several articles have appeared discussing this development of the centrifugal pump, and among them we note a paper presented before the *Société des Ingénieurs Civils de France* by M. Sosnowski, and one in the *Zeitschrift des Vereins Deutscher Ingenieure* by Herr H. Dubbel, while the application of such machines to mining operations is treated by Inspector Julius Divis in the *Oesterreichische Zeitschrift für Berg und Hüttenwesen,* from all of which papers we make some abstracts.

The De Laval steam turbine is one of the best known machines of this type, and since it employs but a single steam wheel it necessarily operates at such a high rotative speed that it is obliged to use gearing to reduce the rotations to a number which can be employed in practical engineering work. Ordinarily the De Laval steam turbine is run at speeds of 20,000 to 30,000 revolutions per minute, being fitted with a reduction gearing of 10 to 1, to enable it to be connected to other machines. It has now been found practicable to utilize the direct speed of the De Laval wheel for the driving of a cetrifugal pump, with the result of increasing very greatly the head against which the pump can deliver water. Thus the ordinary type of centrifugal pump can operate against a head of 15 to 30 metres, but it has been found possible to connect a pump disc directly with the shaft of a De Laval turbine, running at 20,000 revolutions per minute and delivering 1,000 litres of water per minute against a head of 150 metres.

A pump wheel proportioned to be operated at such high rotative speeds is necessarily small in diameter and not adapted for the suction of the water. For this reason a combination has been made, using two centrifugal-pump discs, in connection with the usual arrangement of De Laval turbine. One pump disc is connected directly with the turbine shaft, while the other is driven from a second shaft geared at a lower speed. The slower pump draws the water from the lower level and delivers it to the high-pressure disc, and in this manner a very useful and effective combination is made.

In running several centrifugal pumps in

series it is not necessary that they should be operated at different speeds, and the usual plan is to place several discs upon one shaft and have each pump feed the water to the next. In this way a cumulative effect is obtained, enabling high heads to be overcome. Such an arrangement is especially applicable to electric driving, and pumps of this kind are now made by a number of manufacturers. Among these we may note an arrangement by Messrs. Sulzer Brothers, the well-known steam engine builders of Winterthur, in Switzerland. By placing the pumps on a vertical axis, and putting an electric motor on the same vertical shaft, a very compact arrangement is obtained for use for shaft sinking operations in mining. The whole system may be hung in a chain sling and lowered as the work progresses, occupying a minimum of space in the shaft and delivering the water direct to the surface. Such an arrangement has been used in a satisfactory manner against a head of more than 500 metres, showing a total efficiency of 58 per cent.

Another arrangement of multiple centrifugal pumps is that of Jaeger, constructed by several German builders. This pump consists of a series of centrifugal pumps on a single shaft, the pumps being provided with guide vanes, so that they practically form reversed turbines, and giving an excellent example of the reversibility of the hydraulic turbine, to which reference was made last month in these columns.

Among the pioneers in the construction of multiple high-pressure centrifugal pumps may be named Professor Rateau, well known for his work in the development of the steam turbine and of turbo-machines in general. He has been especially successful in the design of combination steam turbine and centrifugal pumping sets for mining service, and one of his machines of 500 horse power is in service at the Bruay mines, delivering 250 cubic metres of water per hour against a head of 350 metres, while others are at work in South America.

The development of the high-pressure centrifugal pump is especially interesting as a pendant to the growth of the use of the steam turbine, and attention is naturally directed to the general tendency in engineering work to get away from the difficulties which are involved in intermittent and reciprocating machines. It has been remarked that the form of steam engine which has, until recently, been generally employed, consisting of a piston having a reciprocating motion in a cylinder, had its origin in the fact that the first steam engines were employed to drive pumps for draining mines. When, later on, it was found desirable to use the steam engine to drive general machinery, the reciprocating engine had a crank attached to it, and thus, indirectly, a rotary motion was obtained. Now the problem is reversed. Having at length become released from the trammels and difficulties of the reciprocating engine by the improvement of the steam turbine, we find the centrifugal pump itself improved to be made suitable for the new conditions, so that the engine determines the character of the pump, just as another type of pump formerly controlled the lines along which the steam engine was at first developed.

THE RECOVERY OF TIN SCRAP.

ELECTROLYTIC METHODS OF TREATING TIN SCRAP FOR THE SEPARATION OF THE METAL FROM THE SHEET IRON.

The Engineer.

ONE of the principal uses to which tin is applied in the arts is for the coating of sheets of iron, these plates being subsequently used for the manufacture of various kinds of utensils and for roofing, and similar purposes. There is thus produced a large quantity of scrap, this including cuttings of the coated metal, and the discarded cans and other old articles of all sorts. The question of the recovery of the valuable tin from this waste has been attempted in various ways. In some cases the articles have been first heated, to separate the solder, and then cast into the cupola with other inferior iron scrap and run into sash weights and other articles in which quality of material is unimportant. The presence of the tin in the product rendered it unsuitable for any structural purposes, and the value of the material thus obtained scarcely paid for the cost of its production.

With the development of electrical methods for various metallurgical processes it has been made evident that the separation of the tin from the iron might be commercially effected, so that both metals would be available for new purposes, and in a recent issue of *The Engineer* some account is given of the methods which have been devised for this purpose.

According to recently published reports, Germany possesses eight factories operating such processes, and these treat annually in this way about 30,000 tons of tin scrap. The average amount of tin in such material is only about 3.5 per cent., so that this corresponds to about 1,000 tons of tin, while the iron being free from alloy is also available for general purposes.

It is not difficult to see how electrolytic methods might be employed for the separation of tin from iron, but the small proportion of the more valuable metal in the material renders it imperative that the process should be an inexpensive one, and it is upon this point that many of the methods suggested have failed.

Details of a number of patents are given in the article referred to, but these may be broadly divided into two classes. In the first the tin is dissolved in an acid solution, either hydrochloric or sulphuric acid, or both, being used. The tin is then deposited by action of the electric current, while the iron is left in the solution and separated as sulphate of chloride. These processes have accomplished the desired result, so far as the separation is concerned, but the cost has proved too great to give commercial success.

The second class includes methods using alkaline solutions, the tin scrap forming the anode, and the solution being effected by the action of the electric current. Such a method is used by Goldschmidt, at Essen, the electrolyte being sodium hydrate, and the tin scrap, contained in iron baskets, forming the anode. This plant appears to be commercially successful, and is reported to be treating 50 tons of scrap per day. Several other plants are reported to be working in Germany, France and Russia, and there is little doubt that with proper attention to details and operative economies the electrolytic process may be made a working success.

"The cost of the electrical energy required to deposit tin from the sodium stannate solution obtained when tin scrap is employed as anode in a bath of sodium hydrate, is comparatively of little account when one bears in mind the value of the recovered tin. Thus a current of 10 amperes at 1½ volts will deposit 11.12 grammes of tin per hour from a sodium stannate solution at 70° C. with tin anodes; and 1 k.-w.-hour will, therefore, yield 733 grammes of tin at the cathode.

"Taking an average energy efficiency for the alkaline recovery process of 60 per cent., we find that 1 k.-w.-hour will yield 440 grammes tin, or that 2,500 k.-w.-hours will be required to yield 1,000 kilogs. (1 metric ton) of pure tin. Assuming the cost of power to be 1d. per k.-w.-hour, the cost of electrical energy per ton of recovered tin is found to be only £10 8s., or less than 9 per cent. of the present market value of the metal.

"The sodium hydrate employed as electrolyte can be used for a lengthened period before the accumulation of impurities in it necessitates its renewal, and therefore the actual running costs of the alkaline electrolytic tin recovery process are remarkably low. The difficulties of the process arise chiefly in connection with the working up of the deposited tin. This deposit is spongy in character, and is therefore troublesome to deal with, in the after melting operations necessary in order to obtain the tin in ingot form. No details have been allowed to leak out concerning the methods used, but it would seem probable that the spongy tin is first subjected to mechanical pressure, and is then melted in the presence of some inert gas or in a vacuum. Some loss of tin in the form of oxide or dross is likely to occur in the process. However, even when allowing 10 per cent. for the losses incurred while obtaining the deposited tin in ingot form, the alkaline electrolytic tin recovery processes ought still to yield a handsome profit, when the cuttings and scrap are obtained at a reasonable cost for collection and carriage, and when a market can be found in the locality for the remaining iron. The acid tin-recovery processes are less favorably situated as regards running costs, for the acid is not renewed, as in the case of caustic soda, but is used up in dissolving the iron, and the saturated solution of ferrous-sulphate or chloride ultimately obtained is not likely to prove a very valuable by-product. Since tin scrap contains on the average only 3.5 per cent. tin and 96.5 per cent. iron, much more ferrous-sulphate than metallic tin is produced by the acid process. Assuming that only 50 per cent. of the iron is dissolved by the acid for each ton of metallic tin recovered, at least 29 tons of scrap will require to be worked up, and 70 tons of crystalline ferrous-sulphate will be produced per ton of recovered tin.

"The market for ferrous salts is, however, limited, and this fact explains the failure of many of the acid tin recovery processes which have received industrial trial.

"The alkaline electrolytic process for recovery of tin from scrap and cuttings is one which is likely to expand into an industry of considerable importance. In most large cities the collection and sorting of the refuse and garbage will in time be carried on under municipal control; and as the use of tin cans for foods is now so general, the amount of tin that could be obtained annually from the rubbish and garbage of our modern cities is much larger than is yet realised. The present methods of collection and despatch of this tin scrap to the German and other foreign recovery works are, however, costly, and it seems probable that the line of future development will be in the direction of tin scrap recovery plants worked as an adjunct of all large municipal electric supply stations. These plants would help to provide the electrical engineer with a day load for his plant, and would only require a chemist and a few labourers for their operation and control.

"Since the plant would draw only upon the local supply of tin scrap and cuttings, the charge for collection and cartage would be low; and a tin scrap recovery plant working under such conditions would be more likely to yield a profit than under the present arrangements in this industry."

THE PROPERTIES OF ALLOY STEELS

THE CONSTITUTION, BEHAVIOUR, AND APPLICATIONS OF STEELS CONTAINING METALS OTHER THAN IRON.

William Metcalf—American Society for Testing Materials.

SINCE the American branch of the International Society for Testing Materials formed itself into an independent organization there has been some cause for surprise that the word "testing" was retained in the name, as nearly all the papers and discussions at its meetings have related to almost anything but the unification of methods of testing materials. Apart from efforts at the framing of specifications, however, there have been presented before the Society various papers upon the general properties of different materials of construction and consumption, and among those at the recent meeting we note one upon alloy steels, by the veteran steel maker, Mr. William Metcalf.

Mr. Metcalf calls attention to the fact that the recognized varieties of carbon steel may be divided into three classes: crucible, Bessemer, and open-hearth steel, and that all three of these contain small quantities of other substances than iron and carbon. Thus phosphorus, sulphur, silicon, and manganese are found, as well as copper and arsenic, but these appear as the remains of impurities rather than as useful ingredients, altogether different from substances deliberately added with the intention of producing certain effects.

"From time to time we have put upon the market silicon steel, phosphorus steel, chrome steel, aluminum steel, none of which have won any permanent place in commerce. Of permanent alloy steels, we have nickel steel, manganese steel, self-hardening or air hardening steel, and the latest, the new variety called high-speed steel.

"Nickel steel, containing comparatively small percentages of nickel, is used chiefly for structural purposes, giving increased strength and toughness. It has been applied mostly to armor plates and gun parts, and lately it is being tested largely in rails to determine whether the increase in durability in difficult places will justify the greater cost over ordinary Bessemer or open-hearth rails.

"Hadfield's manganese steel is unique. Hard, tough, non-magnetic, non-hardening by quenching, non-annealable by any known method, practically unmachineable; it stands by itself, there is nothing to compare it to nor to test it by. It is finding large use for a number of special purposes.

"Self-hardening or air-hardening steel derives its name from the fact that when it is heated to an orange color and allowed to cool slowly in the air it becomes exceedingly hard. Some years ago it was known generally as Mushet steel, from the fact that its first development was due to the distinguished metallurgist whose name it bore. The usual composition of this steel is about 2 to 3 per cent. manganese, 4 to 6 per cent. tungsten, and carbon high."

From the Mushet steel to the modern high-speed steels now appears to be a natural step, although it was a long time before it was taken, and Mr. Metcalf shows an almost amusing unwillingness to believe that the step was taken by design. According to his view of the case some anonymous individual at the Bethlehem Steel Works may have blundered upon the fact that a tool of air-hardening steel was overheated, according to accepted notions, and that it was then accidentally found to be vastly improved. From such a chapter of accidents "the Taylor-White process was developed." There may be some who believe that there was more of accident than design in the work of a trained engineer and a skilled chemist, but such assumptions appear to be unnecessary. However, Mr. Metcalf accepts the results, and subsequently acknowledges that the older men are "standing on their heads once more" and that there has been a revolution in the art of making and using cutting tools of the metal he has spent all his life in making and studying.

After the first surprise, mingled with a dash of incredulity concerning the performances of the new high-speed steels, the matter began to receive general attention in all industrial countries.

"The potentialities were so great that nearly all of the leading steel makers in the work attacked the problem, with the result that the present high-speed steels are in no sense of the word air hardening. Manganese has been reduced from 3 to 4 per cent. to 0.30 per cent. to traces; tungsten has been increased to 10 to 20 per cent., instead of the usual 4 to 6 per cent., and the carbon is generally less than 1 per cent.

"There are about 50 different brands on the market, and of course each one is the best. Perhaps the analyses of two of the leading brands will be interesting, as follows:

	Per cent.	Per cent.
Tungsten	9.99	18.48
Chrome	2.83	2.90
Carbon	0.69	0.78
Phosphorus	0.010	Not determined
Sulphur	0.010	Not determined
Silicon	Trace	Not determined
Manganese	Trace	0.33

Another contains the following:

	Per cent.
Molybdenum	9.65
Chromium	....
Carbon	0.66
Phosphorus	0.016
Silicon	0.046
Manganese	0.22

"In one sense it is chaos. All traditions as to heating are completely reversed, and no one really knows what is the best. One brand is famous for its excellence in one kind of work, another in another kind, no one yet seeming to cover all of the ground.

"One thing is certain, the machine business is revolutionized. These tools have crowded ordinary lathes, planers, drills, etc., away beyond their capacity; machine buiders are remodeling their machines to meet the new conditions, and many of the users are throwing out their old machinery for the new, or else remodeling and strengthening what they have."

Although the introduction of the new steels has caused many changes in machining operations, Mr. Metcalf thinks that the steel maker has the most to learn.

"He must find out why there is such a great difference in the work the steel will do, when there is so little difference in composition. He must find the composition or mixture that will come nearest to meeting all the requirements. He has at his command now ferromanganese, ferrosilicon, ferrochromium, ferrotungsten, ferromolydenum, ferrovanadium and ferrotitanium. These alloys are all expensive, except the first two, costing from 60 cents to $12 a pound; therefore the present prices of high-speed steel, which to some people seem to be of the fancy order, are really not excessive.

"The successful production of the above named alloys marks a great advance in metallurgy, and, now that a demand has sprung up, it is certin that the supply will follow, with certainty and uniformity of composition and reductions of cost.

"The making and the utilizing of steel containing practically only carbon and iron, with some modifications made by the use of small quantities of manganese, silicon, tungsten and nickel, have occupied the best minds in the manufacturing and engineering world for many years. The last half of the nineteenth century saw most wonderful developments produced by the inventions of Bessemer and Siemens, aided by the skill and energy of the brightest engineering minds. At the close of the century it was customary to 'point with pride,' and to assume that so much had been done and so much was known that there was no room for more revolutionary changes, and the coming generation had only to tag along, utilizing these great advances with ease and comfort to themselves and with blessings upon their predecessors."

That this idea was fallacious is now altogether apparent, and the experience of the tool steel maker may well indicate to men in all other departments of work that the field for improvement is always open.

PROTECTION AGAINST EXPOSURE FIRES.

EFFECTIVENESS OF VARIOUS FORMS OF SHUTTERS, WINDOWS AND SCREENS FOR PROTECTION AGAINST EXTERNAL FIRES.

John R. Freeman—Engineering News.

WE reviewed in these columns several months ago the extent to which the buildings of modern fireproof construction had succeeded in resisting the conflagration at Baltimore, and to these we now add some comments upon the valuable address of Mr. John Freeman, before the National Board of Fire Underwriters, and published in *Engineering News*. Mr. Freeman had the opportunity of inspecting the ruins at Baltimore promptly after the fire, and his trained observation at that time has enabled a number of important facts to be secured for subsequent use.

It is generally admitted that the principal defect in the modern buildings, as revealed at Baltimore, is weakness against attacks from fire without. It has been too freely assumed that if a building is so constructed that a fire starting at any point in the interior cannot spread the main result has been accomplished. As a matter of fact nearly every large building has dangerous neighbors, and it has been shown more than once that the vulnerable part of the modern business building is to be found in the opening which permits fire to enter.

A most important protection for windows liable to exposure to external fire is a proper fire shutter. The standard fire shutter at the present time is made of wood, covered with tin, such a construction being generally assumed to be better than a sheet-iron shutter. Mr. Freeman tells the story of the origin of this idea, it being due to the fact that about twenty-five years ago, in a fire in the Pacific Mills at Lawrence, Mass., a tin-covered wooden shutter stood the fire while one of sheet iron warped and allowed the flames to pass around the edges. This case showed that the defect of the iron shutter was its liability to warp, but the reason for warping may be discovered, and in most instances removed by proper construction. The cause of warping is found in unequal expansion, or in the cramping of the shutter so that it cannot expand freely. Ribs, or other strengthening pieces attached to an iron shutter will cause it to warp under heat, and this construction is defective, while the provision of sufficient room for expansion of the whole shutter will avoid the tendency to buckle under heat. A plain steel shutter, well secured and proportioned, will be found to give good protection against fire from without, while for extra protection Mr. Freeman recommends two shutters, the outer one receiving the brunt of the heat and the inner one thus being able to stand out against the duration of almost any fire.

Mr. Freeman gives some excellent advice about the methods of making buildings fireproof against exposure fires, and the suggestions he gives are open to the use of every one, and so may well be generally observed.

"The path of safety from exposure fires for office buildings and the like, lies in a window casing formed so that we can attach to it a shutter of a form similar to the ordinary inside house-blind. Our ordinary business buildings have walls thick enough so that by making the shutter in four folds, or leaves, two being hinged together, and these two in turn attached to the wall, making each fold in the shutter only about 15 ins. wide, the window will be wide enough for all practical purposes, and we can fold the shutter back with the window jamb, very much as we do the inside blind.

"To do that with the ordinary tin-clad shutter would be almost impossible, because of the thickness of that form of shutter. It can be done with a steel plate shutter without ribs, and the radiation from the inside can be checked by some thin incombustible porous covering like asbestos board. If in our underwriters' laboratories, in our technical schools, and in our tours of survey we can direct attention to these views and urge the solution of the problem of how to make an efficient fire shutter which shall only be ¾-in. or 1 in. in thickness, I believe that before long the problem of protecting an office building against exposure fires will be found solved.

"It is entirely possible to design a window opening adapted to receive a safe shutter, so that it will be just as convenient for ordinary business purposes as the type now common. I think it probable that the best place for the shutters is inside the glass, sacrificing the glazed sash outside them in case of any great conflagration.

"We hear a good deal nowadays about 'water curtains,' and I would like to say just a word on that, because I think there is a gerat deal of misapprehension about their efficiency. I would like to say a word about wire-glass also, because, although in general excellent, I think there is a great misapprehension as to what wire-glass can do.

"I began experimenting with wire-glass very soon after it first came out, and I have used it in numerous instances, and it is a most excellent material in its way, but it has its limitations; it has the same limitations that a water curtain has, and that is, that it does not stop the passage of radiant heat.

"You all have noticed how, when you are traveling in a railway train, perhaps at 60 miles an hour, and they happen to be burning a pile of ties along the track, that although your face is directed towards your newspaper, you will feel the flash of heat passing through the car window and striking against your face as you go past that pile of burning ties. That simply illustrates the great ease and rapidity with which radiant heat passes through glass.

"Now, radiant heat passes through glass with wire netting in it almost as easily as it does through any other glass, and the record made by wire-glass in a certain building in Baltimore, which is pointed to with so much pride, is, I think, simply due to the fact that it was at a place where nothing combustible was immediately behind it. If you have a stock of dry goods, or wooden ware, or baled cotton or hemp just inside a wire-glass window without shutters, and there is a hot fire across the street, these can probably be set on fire with much promptness by the radiant heat passing through the glass, and the subject should be thoroughly studied on a large scale in our underwriters' laboratories. For safety, there must be something which will stop the radiant heat, and that can only be in the form of a shutter, and, by virtue of stopping the heat, the shutter will become hot.

"The case with the water curtain is very much the same as with the glass. Water is diathermous, as physicists call it—that is, radiant heat passes through water very easily. We must, I believe, set down these stories that have been told about the efficiency of water curtains as being mainly fairy tales.

"This supposed efficiency of the water

curtain is another topic which I hope that some one of our underwriters' laboratories and some of our schools of applied science will take up and investigate with precision of measurement.

"I have heard stories of the wonderful efficiency of the water curtain, but I must beg to disbelieve them, largely on the theoretical ground as yet. It is a matter which can be tested very easily.

"The window sprinkler came in for a good deal of praise in certain quarters in Baltimore. I took particular pains to investigate that, because I wanted to find just how far they merited it, and I have no doubt they did some good, but they are not entitled to anything like the glory that is claimed for them. In short, if you want to provide against an exposure fire, I believe that the only satisfactory way to do it is:

"First, by a wall either of brick or cement concrete.

"Second, by properly designed window openings and window casings, and

"Third, by good shutters in those windows.

"In the absence of shutters, automatic sprinklers, supplemented by heroic efforts with hose streams on the inside, may sometimes save the day; with great expense for water damage, but where exposures are bad, a good shutter on a proper window should be the first care of architect and owner."

POWER GENERATION FROM HEAT.

RECENT IMPROVEMENTS IN METHODS AND MACHINES FOR THE CONVERSION OF HEAT INTO MECHANICAL ENERGY.

Prof. E. Josse—Verein Deutscher Ingenieure.

At the Paris exposition in 1900 there was a notable display of steam engines, gas engines, and motive-power machinery generally, representing very completely the advanced state of the art as it then existed. During the few years which have elapsed a notable advance has been made in this department of engineering work, and in an address delivered before the Berlin section of the Verein Deutscher Ingenieure, and published in the *Zeitschrift* of the society, this recent development is discussed by Professor Josse.

It is unfortunate that the exposition at St. Louis does not contain a sufficiently complete display of motive power machinery to supplement that at Paris, and the absence of the most important feature of that progress, the large internal-combustion motor, makes the record of the St. Louis exposition disappointingly incomplete to the engineering profession. The paper of Professor Josse, however, reviews the field very completely, and it is to be hoped that it may in some degree supplement this unfortunate deficiency.

The competition of the gas engine has led the builders of steam engines to put forth their best efforts to meet, as nearly as may be, the high economy of the internal-combustion motor, and Professor Josse calls attention to the fact that this rivalry has caused a marked advance in steam-engine performance to be attained. The high economy of certain large steam engines still represents the best performance, but the character of the smaller engines, and the general average of steam economy in practical service has been raised much closer to the higher limit.

As an illustration of modern steam machinery Professor Josse describes the new mechanical laboratory of the technical high school at Danzig, the equipment including several varieties of boilers, a compound horizontal steam engine, a steam-turbine generating set, and a variety of auxiliary machinery. The tests which can be made on such motors shows definitely what may be expected in actual practice, and an important result of the establishment of such laboratories is their education influence upon steam users.

To show the progress which has been made in steam economy in a class of engines in which high performance has not often been considered, the results of tests upon improved portable engines are given. A compound, condensing, semi-portable engine by Wolf, of 45 horse power, using steam at 170 pounds per square inch, superheated 300° C. before entering the high-pressure cylinder, and reheated 190° C. between the high and low pressure cylinders, was tested by Professor Josse, and showed a steam consumption of 4.55 kilogrammes per indicated horse power, or 10.03 pounds, and a coal consumption of 0.556 kilogrammes per indicated horse power, or 1.225 pounds.

These results approach those which have been attained by gas engines, and Professor Josse gives in comparison data and results of tests of a 450 horse power Otto-Deutz gas engine, using producer gas, showing a coal consumption of 0.83 pound at full load, and 1.1 pounds at half load.

The introduction of suction gas-producer plants, operating directly in connection with the engines, is rendering the employment of gas engines much more convenient than when the construction of a complete gas-making installation was required, while the utilization of waste furnace gases is now an accomplished fact in daily service, both in Europe and America, although the single large gas engine designed for such service was regarded as the great curiosity at the Paris exposition in 1900. Professor Josse estimates that the gas produced per ton of pig iron manufactured will give about 1,000 horse power, if used in properly designed gas engines, while but 300 horse power would be obtained by burning the same gas under steam boilers. This estimate is somewhat larger than others have made, the figures given by Mr. Uehling, at the New York meeting of the American Society of Mechanical Engineers, being about 840 horse power per ton of iron made, but the gain of the gas over the steam engine in this connection is undoubted. Illustrations of a number of the larger gas engines of recent design by the leading makers are given in the paper, and details of arrangement and of gas purifying plant.

Professor Josse discusses the rivalry of the steam turbine with the reciprocating engine, and gives a number of curves showing the comparative performance. These demonstrate that the turbine is even now giving as high results as the reciprocating engine, so that the advantages as to space, maintenance, convenience, etc., are additional gains. By the use of the low-pressure turbine of Rateau, in connection with his steam accumulator, the large losses now incurred with winding engines, pumps, and other intermittent reciprocating engines, may be prevented, and plants already installed may have their economy greatly improved.

It is to be expected that Professor Josse would make some reference to his own "waste-heat" engine, this being a form of binary-vapor engine already discussed in these pages. As is well known, in these engines the heat of the exhaust from a steam engine is used to vaporize a volatile liquid which is employed in a second engine, this vapor being then condensed and used repeatedly. The engine of Josse uses sulphurous acid for the second engine, and several installations of the system are shown in the paper. There is no doubt that this method may be used to advantage to render a wasteful steam engine more economical, by recovering a portion of the heat energy passing out with the exhaust, but the economy of such a combination does not appear to be higher than can be attained with the best modern single steam engines.

Practical experience, however, both in Europe and America, with binary-vapor engines, using ether, ammonia, bisulphide of carbon, and similar volatile liquids, appear to show that the gain in power is hardly commensurate with the increased complication and expense, and that the system has but limited application.

In general, the progress which has been made in heat motors during the past few years has been shown to be marked, and this is of especial interest when it is realized that the advance has been along the lines of scientific investigation. The practical engine builder, whether constructing reciprocating engines, steam turbines, or internal-combustion motors, has availed himself of the latest scientific researches, and instead of attempting to devise something in the nature of a startling invention has simply applied, to the best extent of his resources, the results of studies in thermodynamics for the conversion of heat energy into mechanical energy. The result has been a steady progress, advancing step by step, and enabling a continually increasing proportion of the sources of power in Nature to be directed to the use and convenience of man.

THE TEHUANTEPEC RAILWAY.

THE COMPLETION OF THE RAILROAD BETWEEN THE ATLANTIC AND PACIFIC OCEANS ACROSS THE ISTHMUS OF TEHUANTEPEC.

E. L. Corthell—Railroad Gazette.

AMONG the various routes by which it has been proposed to join the commerce of the Atlantic with the Pacific, the Tehuantepec isthmus has long been considered. It has even been proposed to cut a ship canal across at this point, and the late Captain Eads designed a ship railway, and worked out the details in a very complete manner in connection with this route. Apart from the consideration of the isthmus as a possible point for interoceanic communication, however, it offers numerous advantages as a route for the railway development of this portion of Mexico, and hence the plans for a railway have, with numerous vicissitudes, been carried along until the work is now nearing completion. The present state of the project is very fully described in a paper by Mr. E. L. Corthell in a recent issue of the *Railroad Gazette*, from which we make an abstract.

The railway, which will be completely ballasted by the close of the present year, extends from the port of Coatzacoalcos, on the Gulf of Mexico, to Salina Cruz, on the Pacific ocean, a distance of 180 miles. The principal work then remaining to be done will be the improvement of the harbors at the terminals, for which it is estimated that ten million dollars in gold will be required. The work is being conducted by Messrs. Pearson & Sons, of London, in partnership with the Mexican Government, and it will now undoubtedly be pushed to a completion as a portion of the railway system of the republic of Mexico.

It is the view of the contractors and the government that the Tehuantepec Route will be entirely completed and in full operation with its own line of steamships eight years before the Panama Canal can possibly be opened to interoceanic traffic; that the Tehuantepec Route has immense geographic and navigation advantages over Panama and that it can easily draw to itself in the eight years all the traffic naturally tributary to it, and that, even after the opening of the Panama Canal, its excellent facilities for the prompt and economical handling of freight from ship to car and car to ship, will enable it to hold all it will have acquired; also that the ever-increasing volume of the world's commerce and of interoceanic traffic will enable the Tehuantepec Route to acquire its share of this increase, sufficient to make the great investments of the Government yield a fair return. It may be stated also that the Government of Mexico and its people have always believed it was their duty to the world to develop what they believe to be the natural and most advantageous route for the commerce of the world to pass between the oceans.

Mr. Corthell relates at length the history of the various plans which have been made, since the days of Cortez, to effect a highway across the continent at Tehuantepec, and shows that the failure of many of the schemes to materialize has been due to the unsettled political condition of the locality. The concession under which the present line has been built was originally granted to Mr. Edward Learned, of New York, by whom 35 kilometers of the line were constructed. At the expiration of the period, in 1882, the property was purchased from Mr. Learned by the Mexican government, and the authorities then proceeded to complete the railroad.

"The ascent from the Gulf of Mexico is gradual, over slowly rising land, to the table land, where the summit is about 924 feet above sea level. The descent to the Pacific plains is much more abrupt. The plains on the Atlantic slope are, however, undulating and are traversed by many lateral streams of considerable size, tributary to the Coatzacoalcos, which is the main drainage of an extensive country subject to an annual rainfall of about 100 inches. The irregularities required in the preliminary construction an undulating grade and considerable sharp curvature. The heavier grades were from 1½ to 2 per cent. and the maximum curvature about 9 degrees about 600 feet radius. The work of the present contract consists largely in cutting down unnecessary grades and in improving the alinement. The whole length of the route is 290 kilometers (180 miles). The gage is the standard of the United States—4 feet 8½ inches.

"The rail originally laid was 56 pounds per yard. That required by the present contract is 80 pounds. The original rail is all being renewed. The bridges were mostly wooden trestles and pile bridges, except over large rivers. Permanent structures, masonry or steel, are now being substituted for them. The entire line is being ballasted, sidings are being lengthened, yards laid down and the whole route put into shape for a heavy interoceanic traffic, and the rolling stock is being supplied to meet the requirement."

An interesting feature of the route appears in the fact that at Sta. Lucretia, about half-way across the isthmus, the new line connects with the Vera Cruz and Pacific Railroad, and through this with the general railway system of Mexico, extending to the frontier of the United States. This makes a long link in the proposed Intercontinental Railway from New York to Buenos Ayres, and adds materially to the importance of the new line. So far as the Intercontinental Railway is concerned, it has been argued that this line, if ever completed, cannot expect to compete with a deep-water rival, but there appears to be no reason why the development of the country through which the line passes should not be taken into consideration.

Mr. Corthell describes at some length the plans which have been undertaken for the improvement and development of the harbors at the two terminals, and this is a matter of especial importance, since the merchandise transmitted by this route will have to be unloaded and reloaded at each end of the line.

"It is assumed that at Tehuantepec the methods of handling cargo are the best and the quickest now employed anywhere. If the steamers built for this route are designed like the Morgan line steamers running to New Orleans and Galveston from New York, they will be able to discharge or load 5,000 tons of freight on board cars or on board ship in ten hours. This is done regularly at Algiers, opposite New Orleans. Each of the three under decks for freight has great side ports hermetically sealed on the voyage, but opened up as the steamer lightens up in discharging. These ports are high enough so that a gang of men can truck the freight out of the ship into the cars, which have their floors at the level of the wharf floor. When the upper deck has been unloaded the ship lightens up out of the water sufficiently to allow the next set of side ports to be swung open, and so on to the third. Heavy freight—machinery, etc.—which cannot be readily trucked out is stored near the hatchways and lifted out by the ship's tackle and loaded on flat cars, which stand on a track immediately under the ship's side. The steamers are loaded from the cars in the same manner and in the same time. Ten hours will suffice to transfer a cargo of 5,000 tons from the steamer to a train of cars and start it on its journey over the Isthmus."

The additional cost of the handling, Mr. Corthell believes, will be more than overcome by the fact that there is an advantage of four days' time between New York and San Francisco over the Panama route. Assuming a traffic of 6,000,000 tons as available for trans-isthmian business at the present time, Mr. Corthell believes that in the eight years' start which it will have, the railway will be able to secure at least one-half of this business, and to hold all that it has acquired, even after the Panama canal is completed and in full commercial operation.

BOILER-HOUSE ECONOMIES.

THE PROBLEM OF PRODUCING ELECTRICAL ENERGY FROM STEAM POWER AT A MINIMUM COST.

R. S. Downe—Municipal Electrical Association.

At the recent Sheffield meeting of the Municipal Electric Association a very practical paper upon boiler-house economies was presented by Mr. R. S. Downe, from which we give some abstract.

"The problem is to deliver a unit of electricity at the station busbars, with the maximum number of lb. of coal, and this question is the most difficult one the engineer has to face in the power house, but the one most likely to give the best money return for the time expended on it. Coal in some cases accounts for 50 per cent. of the total costs. The great majority of stations burn bituminous slack, costing from 6s. to 12s. per ton delivered in the bunkers. Where the railway rate is high and smoke conditions stringent, Welsh coal is used; in a few cases where it is available, smudge, or low grade fuels are burned. This point is entirely settled by local conditions.

"Assuming bituminous slack is used in a well-designed condensing station, with economisers and superheaters, and a load factor not less than 15 per cent., coal ought not to exceed 5 lbs. per unit, including all the losses between the furnace and the engine. Several private industrial plants are now generating a unit of electricity with 3 lbs. of cheap slack. The results are excellent, but under the same conditions one could do better.

"It is necessary to have a rigid weekly analysis of units generated, together with coal and water used. It is possible for all to obtain the weekly consumption of coal, and thereby calculate the lb. of coal per unit generated."

Mr. Downe examines the effect of output and load factor, showing especially the pronounced effect which a bad load factor has upon boiler-room losses. He recommends the use of the minimum number of boilers possible, helping them over the peak of the load by some form of assisted draught. He also discusses the personal factor as shown in the varying performances of different firemen and believes that the adoption of a bonus system will be of value in securing the best work from the men.

In regard to the value of superheating Mr. Downe has some very definite opinions.

"No practical difficulties are experienced in using a moderate superheat up to 500° F. The saving in coal and steam may amount to between 10 and 20 per cent., and is greater where the engines are working under uneconomical conditions, and where a steam ring is in use, or the steam ranges are inordinately long. A superheater attached to a boiler may abstract 10 per cent. of the heat in the flue gases, and reduce the efficiency of the boiler by this amount; but as this 10 per cent. extra heat in the steam may reduce the engine losses by 20 per cent., the net gain is very great, and alone would warrant adoption. The saving in steam is greater than the saving in coal, due to fuel being required to obtain the superheat."

So far as mechanical stokers are concerned, there does not appear to be any very great economy shown by their use. When the coal has to be thrown into the hoppers by hand, there is no saving in labor, and the interest, depreciation, and operative charges go far to offset any actual economy in performance.

Mr. Downe touches upon a very important source of loss in the matter of air leakages.

"Most boilers are surrounded by a quantity of brickwork which is notoriously porous, and as this brickwork is subjected to great changes of temperature, the air leakage becomes excessive unless it is receiving constant attention. Air leakages being inwards are of an insidious character, as they do not show themselves but have to be searched for.

"When boilers are shut down under natural draught, there is always considerable air leakage into the main-flue, even when the dampers are closed. Sliding dampers require to be an easy fit in their frames, but in most cases this is overdone; an improvement on the usual type of damper might be easily fitted. The brickwork round damper-frames is difficult to inspect; generally on being opened up it is found to pass cold air at every joint. This air has a considerable cooling effect on the gases; it decreases the draught and lowers the economiser efficiency."

The losses due the low efficiency of the auxiliary machinery may be materially reduced in an electric-power station by driving all such machines electrically, and the steam required for these purposes may be reduced from 3.5 per cent. to 1.5 per cent. of the total output.

"In every case where water is treated, it should be done externally, before entering the boiler. For economical steaming, a boiler should be clean inside and out, because the transmission of heat is rendered easier, and the evaporation is increased.

"It is a generally accepted fact that no economy can be obtained by raising the temperature of feed water except by heat which would be otherwise wasted. Is it possible, by having separately fired feed heaters in series with economisers, to put the water into the boilers at the same temperature as the steam, and so obtain more duty per boiler, and reduce the number under steam, thus effecting a saving in coal? The true function of a boiler would then be steam raising, and not feed heating in addition.

"When the boilers and piping have been covered with the most suitable material, it is necessary to have the latter periodically examined and repaired, as it is usually of a perishable nature. When it is enclosed in a metallic envelope, much waste may be caused if there is contact between the piping and the shield, which may be at nearly the temperature of the steam. Condensation may be reduced one-half if the valve bodies and flanges are covered. The joint itself may be left exposed, but with superheated steam there is little trouble from leaky joints, if the ranges are well fitted and properly drained.

"Perfect combustion of fuel cannot be obtained in any form of boiler, but it ought to be possible to considerably raise the low thermal efficiencies at which most of them are working at the present time. The two essentials are:—The highest possible initial temperature in the combustion process, as the heat transmission between the water and the hot gases is directly proportional to their difference of temperature; and a high temperature in the combusion chamber, so that the volatile gases are not cooled down before combustion takes place. To obtain full value from bituminous coal is an exceedingly difficult matter, and the numerous papers which have dealt with this problem do not assist us much.

"The subject is usually dismissed as follows:—'In a properly constructed furnace these valuable hydrogen units can be utilised to their full value, but time does not permit of going further into this matter.' What engineers are seeking is the properly constructed furnace, suitable for the particular class of slack to be burnt.

"Electrical engineers have made great progress in this special branch of steam engineering, due in great measure to the fact that they are the largest purveyors of energy in a form which is readily and accurately measured. Before the advent of electricity supply, these investigations were entirely in the hands of marine and water engineers, who were restricted to measuring their energy in indicated horse-power-hours, which is neither a convenient nor particnlarly accurate method."

THE GENERATION OF STEAM.

A STUDY OF THE FUNDAMENTAL PRINCIPLES INVOLVED IN THE MANUFACTURE OF STEAM FOR THE GENERATION OF MOTIVE POWER.

A. Lencauchez—Société des Ingenieurs Civils de France.

THERE is appearing at the present time two distinct tendencies in the production of motive power from heat. One of these involves the containing of the entire operation within the motor, and is illustrated by the forms of internal-combustion motors which use liquid fuel directly in the machine itself. Such machines of which the petrol motors, the Diesel and the Banki motors are good examples, are practically self-contained, the entire transformation of the heat into mechanical energy being effected within the motor itself. The earlier steam engines were somewhat of this type, at least to the extent that the engines and boilers were always closely associated and frequently combined, but the present tendency is distinctly toward the construction of large steam generating plants, separating the production of the steam, to a large extent from the machinery by which it is to be utilized. It is this phase of the subject which is treated in a paper presented by M. A. Lencauchez before the Societé des Ingenieurs Civils de France, and published in *Mémoires* of the society.

After referring to the increasing size of steam generating units, both in the modern power house and on the large ocean steamships, Mr. Lencauchez calls attention to the increasing importance of compactness, space being of value both in buildings and in vessels. At the same time, it is generally assumed that large steam boilers operating slowly are more economical of fuel than the modern compact, intensive steam generators, so that there are various conflicting elements to be considered. Broadly, four principal defects in steam-boilers may be considered, in studying the problem:

Boilers of the elephant or semi-tubular construction are far from giving in practice a combustion equal to the theoretical. Again, these boilers abstract very imperfectly the heat from the products of combustion. By reason of defective circulation, some portions of such boilers become dangerously overheated, and finally;

The incomplete combustion results in the production of dense smoke, demonstrating the correctness of the preceding statements.

In examining the elements upon which correct boiler design may be based, Mr. Lencauchez uses data of tests ranging from 1863 to 1894, by such careful observers as Morin, Tresca, Henry, Baudry, Normand, Witz, and others, these showing the results obtained with widely differing types of boilers, over a long period of years. These experiments cover data as to the influence of the proportion of air upon combustion, upon the conductivity of various metals, upon the rate of drop of temperature of the gases in passing from the fire box to the chimney, and upon the influence of variations in design upon boiler performance. Mr. Lencauchez also examines the relative performance of condensing and non-condensing engines, considered with regard to steam economy.

So far as the conductivity of the metal is concerned, we are far from possessing positive information, since nearly all investigations give only the relative conductivity of different metals. Recent experiments, however, enable some practical data to be obtained. Thus, tests made upon copper evaporating coils, and upon triple-effect evaporating vacuum pans, show a transmission of heat ranging from 2,000 to 3,000 calories per square metre per hour, per degree centigrade difference of temperature. Tests upon a Belpaire boiler, evaporating 15,500 kilogrammes of water per hour, with a consumption of 2,000 kilogrammes of coal, show that this performance corresponds to a transmission of only about 100 calories per square metre, per degree, per hour; or only one-twentieth of that attained in the previous tests.

In comparing these and other data bearing upon the question, M. Lencauchez is convinced that it is a mistake to consider the evaporative power of a steam boiler as a function of the heating surface. Apparently no definite relation between these two quantities has yet been accurately formulated. Thus a boiler having 100 square metres of heating surface and a grate of two square metres area will give a certain evaporation. If now the area of heating surface be reduced to 50 square metres, while the grate and rate of firing remain unchanged, the evaporation will be but slightly affected, possibly being reduced about 10 per cent. Thus, in the first case an evaporation of, say, 15 kilogrammes of water per square metre per hour, will become 27 kilogrammes per square metre; showing the inadequacy of the use of the area of heating surface as a measure of evaporative power.

As a matter of fact a surface condenser is expected to convert all the steam evaporated by a boiler back into water again with only about one-fourth of the surface allowed in the boiler, and with a temperature difference of only about 50° C., instead of the 800° existing between the boiler and the hot gases.

A far more important element in the transfer of heat is found in the maintenance of close contact between the heating surface and the water, and methods of design and operation which enable this to be accomplished should be considered. This effect is partially produced by a good circulation, and in some instances mechanical appliances have been added to aid in keeping the water in motion and sweeping the bubbles of steam away from contact with the heating surface so as to permit the water to absorb the heat.

The manner in which the heat is absorbed from the hot gases by the water through the heating surface, has been made the subject of careful study. It has been investigated by measuring the drop in temperature from the fire-box end to the smoke-box in the tubes of locomotive boilers, and although the result shows an extremely rapid fall of temperature in that short distance it is by no means so quick as has been sometimes supposed, or than is necessary for the complete absorption of the heat.

Thus, in experiments upon locomotives of the Orleans railway, with tubes 5 metres long, and an air suction of 50 mm., the temperature of 1,600° C. in the fire-box fell to 400° in the smoke-box, this drop of 1200° taking place in one-tenth of a second.

M. Lencauchez examines the construction of a great variety of boilers, together with such auxiliary apparatus as economizers, superheaters, condensers, etc., and his conclusions, which are indicative of the nature of his investigations, are summarized here.

It is evident that we are yet far from utilizing the full conductibility of the metals employed in steam boiler construction. It also appears boilers of intensive action, such as locomotive boilers, and the express water-tube boilers used on torpedo boats and the like, utilize the heat to a better advantage than those which are fired slowly and are slow steamers. For engines working with double or triple expansion, and at the high pressures now possible, the advantages of superheating become less and less, while with properly proportioned boilers there is no real advantage to be gained by the use of economizers.

The condensing engine, as ordinarily constructed, is not materially more economical than the non-condensing type, the advantage due to the vacuum being largely overcome by the cost of getting it. If a practical gain is to be obtained by condensing, it will be best secured by the use of a carefully designed central condenser, with independent pumps, the supply of condensing water and the speed of the pumps being regulated by the vacuum.

The use of a feed water heater and purifier, delivering the water to the boiler at about 96° C., is found to be the most practical device for this purpose, giving a real economy of 9 to 10 per cent. over and above all charges which may properly be made against it.

Some of these views will doubtless be regarded as heretical, but they are based on careful study of existing facts, extending over a long series of years, and freed from the bias which sometimes attaches to arguments by men who are interested in demonstrating the advantages of some especial device. The paper of M. Lencauchez is well worthy of careful study, even if all of his conclusions may not be accepted.

MOTOR BOAT TRIALS.

PRACTICAL EXPERIMENTS UPON THE RELIABILITY OF INTERNAL-COMBUSTION MOTORS FOR THE PROPULSION OF BOATS.

Engineering.

THE so-called motor-boat has increased greatly in vogue during the present season and a large number of small boats are now equipped with machinery similar to that upon road automobiles. Some remarkable results as to speed are reported from time to time, but there has been a general disposition to regard these interesting craft as rather unreliable, and as ready for breakdowns or disabling as their rivals upon the road. For this reason the reliability trials recently conducted in England under the auspices of the Automobile Club under the control of a committee containing such members as Dr. Boverton Lloyd, Sir John Thorneycroft, Mr. F. A. Yarrow, and other experts demand interested attention. From a report of these trials in a recent issue of *Engineering* we give some of the results, and fuller information will doubtless be forthcoming at a later date.

The object of the trials is an important one, being to prove to naval authorities, shipping companies, yacht owners, and the public generally, that boats propelled by internal-combustion engines can be depended upon for continuous running for various purposes; that they can be made a safe, cheap, and reliable means of transport.

The trials were run over a course of 9½ nautical miles long, in Southampton water, and the competitors were required to run over the course continuously for ten hours of each of two consecutive days, making a total run of twenty hours. Marks were made for reliability, account being taken of every stop; for speed, for safety, and for economy, the boats being divided into six classes, according to size. Sixteen boats were entered, of various sizes and powering, and the motors represented the work of some of the best-known makers in the automobile business. The trials appear to have been made in a very general fashion, the horse-power of the motors being taken upon the builders' representation, no indicating being practicable, while the only dimension taken into account was that of length, beam being neglected, and no handicap nor time allowance being given. Since the main feature under consideration was reliability, however, these points were not material, and in future tests doubtless greater elaboration in requirements will appear.

In general the results were very satisfactory, only two boats out of the sixteen being obliged to give up, and these mishaps were not due to any serious defect in the design or construction of the motors. Speeds from 9 to over 14 knots were made by some of the boats, and although full reports of the trials are lacking, the results are most gratifying.

Although most of the boats which have been fitted with internal-combustion motors are of small size at present, there is every reason to believe that these craft will become of very general use and will be built in large sizes, as soon as their entire reliability is established. Many of the conditions which render these small, quick-running motors unreliable on the road are absent on the water. There is no dust to be contended with, and there is ample opportunity for keeping the cylinders cool. The necessity for extreme lightness is absent, so that the operative parts may be made a trifle heavier, just enough to give a good factor of safety, instead of running so close as to leave little margin against sudden and unforeseen strains. The parts may be made more accessible, and many points of convenience may be provided, so that the opportunities for reliable working are far greater afloat than ashore.

With the success of the small motor boat in general service may be expected the development of the internal-combustion motor to larger craft. Petrol or benzine can hardly be available in such cases, but there is every reason to believe that motors using kerosene and the heavy petroleum oils will be made applicable to marine service, and we have already noted the successful use of the Diesel motor in this manner in France.

There is a natural prejudice among nautical men in favor of steam for propulsion, as against the use of the internal-combustion motor, and it must be said that there are some good reasons for such opinions.

"It is a long step from 200 or 300 horse power to the 2,000 horse power of a torpedo boat, still more to the 6,000 or 7,000 horse power of a destroyer; and some very difficult problems remain to be solved. The certainty and flexibility of steam, the ease with which an ordinary steam engine can be reversed, its accommodation to the varying speed of turning, and many other practical points go very far to compensate for the inefficiency of steam, and the drawbacks incident to the boiler. Moreover, we must remember that the great success of the internal-combustion engine for road locomotion has been achieved with petrol, but that is too costly for large powers. Directly we get to a heavier and cheaper fuel the difficulties increase enormously; indeed, the kerosene engine has yet to prove its profitable application, either on wheels or afloat. We remember Sir William White's remarks in his address as President of the Institution of Civil Engineers, and it may be the solution to the problem of the internal-combustion engine afloat may be through solid fuel gasified in producers, which would take the place of steam boilers. A bar to progress in this direction is that advance is hardly to be made from small beginnings, step by step, in the way that technical suggestion is generally translated into commercial practice through the medium of small craft; for we cannot imagine any of the craft in these competitions with gas producers on board. From land to sea is a big jump in engineering practice, but the way in which the use of gas engines is extending is pregnant of suggestion; for instance, one firm alone of Continental makers, and that not in a great engineering centre, has now orders for gas engines of over 500 horse power, to the extent of 80,000 horse power."

THE ENGINEERING INDEX

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The following pages form a DESCRIPTIVE index to the important articles of permanent value published currently in about two hundred of the leading engineering journals of the world—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every article.

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(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published.

We supply the articles themselves, if desired.

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer and works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of any article referred to in the Index, together with all illustrations, can usually be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the journals indexed are given.

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CIVIL ENGINEERING

BRIDGES.

Bascule.

The Broadway Bascule Bridge at Milwaukee, Wis. John Geist. Illustrated detailed description of a bascule lift bridge, possessing novel features in design and construction. 2000 w. Eng News—July 14, 1904. No. 63831.

Cantilever.

A German Long-Span Cantilever Highway Bridge. Drawing and brief description of the longest span in Germany. 700 w. Eng News—July 14, 1904. No. 63834.

Concrete.

A Concrete Railway Bridge. Illustrated brief description of a bridge on the Illinois Central R. R., near Carbondale, Ill. 1000 w. Trac & Trans—July, 1904. No. 64001 E.

Iron Bridges.

The First Iron Railroad Bridge. F. C. Coleman. Illustration, with the history of a bridge built in 1823 for the Stockton & Darlington Railway in Great Britain. 800 w. R R Gaz—July 8, 1904. No. 63707.

Manhattan.

Architectural Features of the Manhattan Bridge. Illustrations, with notes of this bridge across the East River at New York, officially known as No. 3. 1200 w. R R Gaz—July 1, 1904. No. 63626.

The Manhattan Bridge Across the East River, New York City: Revised Plans. Brief illustrated description of proposed changes in the design, with extract from a letter by Carrère & Hastings, giving an outline of the reasons for the architectural changes. 1400 w. Eng News—July 7, 1904. No. 63701.

Movable Bridges.

Movable Bridges. George H. Norton. Considers recent economic changes, and the present tendencies in design, noting the limitations and some of the objects sought. Ills. 5300 w. Trans Assn of Civ Engrs of Cornell Univ—1904. No. 63609 F.

Plate-Girder.

The Erection of a Three-span Plate-Girder Bridge. Illustration, with brief description of the construction of the bridge at Newark, N. J., which carries the tracks of the Central R. R. of N. J. across the Pennsylvania R. R. 2000 w. Eng Rec—July 23, 1904. No. 64048.

Progress.

Progress in Railroad Bridge Building. F. C. McMath. Address before the Detroit Engng Soc. Reviews the progress made in this field in the United States, and some of the causes of the changes in design, with information of interest. 1800 w. Jour Assn of Engng Socs—June, 1904. No. 64135 C.

Reinforced Concrete.

Reinforced Concrete Bridge at Soissons (Pont en Béton Armé à Soissons). M. Riboud. The bridge is of three arches of 24 metres span each, on the Hennebique system. Description of tests and diagrams of deflections are given. 2000 w. Génie Civil—June 18, 1904. No. 63914 D.

Some Observations of the Design of Reinforced Concrete Bridges. W. J. Douglass. Gives suggestions based on observations during a trip made for the purpose of inspecting concrete and concrete-steel bridges. 1700 w. Eng News—July 14, 1904. No. 63836.

Rhine.

The Competition for a Highway Bridge Over the Rhine Between Ruhrort and Homberg (Der Wettbewerb um eine Feste Strassenbrücke über den Rhein zwischen Ruhrort und Homberg). Karl Bernhard. With description of the requirements of the competition and illustrations of some of the designs submitted. Serial. Part I. 1800 w. 2 plates. Zeitschr d Ver Deutscher Ing—July 2, 1904. No. 63904 D.

The Construction of a Highway Bridge Over the Rhine Between Ruhrort and Homberg (Die Erbauung einer festen Strassenbrücke über den Rhein zwischen Ruhrort und Homberg). F. Bohny. Describing the situation and illustrating some of the proposed designs. 2000 w. Schweiz Bauzeitung—June 18, 1904. No. 63967 B.

Swing Bridge.

The Reconstruction of the Rye Swing Bridge. E. R. Waight. Illustrated description of the new bridge over the Rother River. 2200 w. Engr, Lond—July 15, 1904. Serial. 1st part. No. 64098 A.

Viaducts.

Notes on a Foreign Contract. A. B. Lueder Concerning the contract for twenty-seven viaducts in British East Africa on the Uganda Railway, awarded to the American Bridge Co., of New York. Ills. 3300 w. Trans Assn of Civ Engrs of Cornell Univ—1904. No. 63608 F.

CONSTRUCTION.

Armory.

The Seventy-first Regiment Armory Building, New York. Illustrated description of a brick, stone and steel structure about 96 feet high, with tower over 300 feet above the street. 3800 w. Eng Rec—July 2, 1904. No. 63658.

Bins.

Some Formulas and Tables for Bin Designing. R. W. Dull. A summary of the principal formulas required, with tables of pressure-constants for several cases of bins or hoppers for anthracite, bituminous coal, ashes, and sand. 2500 w. Eng News—July 21, 1904. No. 64037.

Building Construction.

Sky-Scrapers. Arthur W. French. Considers the construction of tall steel-framed buildings, and the engineering problems involved. 5200 w. Jour Worcester Poly Inst—July, 1904. No. 63810 C.

The Engineer, the Architect, and the General Construction Company. Reginald Pelham Bolton. An arraignment of the abuses existing in the present practice of conduct of the engineering portions of modern building construction. 3000 w. Engineering Magazine—August, 1904. No. 63975 B.

The Railway Exchange Building, Chicago, Ill. Illustrations, with brief description of a fine building to meet the needs of the railroads centering in Chicago for general office purposes. 500 w. Archts & Builders' Mag—July, 1904. No. 63712 C.

Concrete Work.

Forms for Concrete Work. G. R. Wadsworth. Illustrates and describes types used. 600 w. R R Gaz—July 8, 1904. No 63708.

Fire Protection.

An Engineer's Suggestions to Fire Underwriters. John R. Freeman. Address at the banquet of the Nat. Board of Fire Underwriters, New York. On lessons from the Baltimore fire. 4800 w. Am Archt—July 16, 1904. No. 63850.

Shutters and Other Devices for Protection Against Exposure Fires. John R. Freeman. Extracts from an address before the Nat. Board of Fire Underwriters, New York. Facts learned from a study of the Baltimore fire. 2200 w. Eng News—July 14, 1904. No. 63835.

The Recent Conflagration in Baltimore. C. L. Norton. Calls attention to technical lessons to be learned from this disaster. Ills. 3500 w. Tech Qr—June, 1904. No. 63875 E.

Reinforced Concrete.

Concrete-Steel Stairway Construction; New York Rapid Transit Railway. Illustrated detailed description of the exit stairways. 700 w. Eng News—June 30, 1904. No. 63587.

Cross-Bending Tests on Beams of Reinforced Concrete. Malverd A. Howe. Gives results of a series of tests. The object was to obtain the actual strength in cross-bending of full-size concrete beams reinforced with corrugated bars, according to the formula of A. L. Johnson. 1800 w. Jour W Soc of Engrs—June, 1904. No. 64140 D.

Flexure of Reinforced Concrete Beams. W. K. Hatt. An account of experimental tests made by the writer, giving a straight-line formula and a diagram representing equations, with explanations of their use. 4000 w. Jour W Soc of Engrs—June, 1904. No. 64139 D.

Prussian Regulations for Reinforced Concrete in Building Construction. A copy of the regulations sent to the building authorities April 16, 1904. 2200 w. Eng Rec—July 2, 1904. No. 63664.

Reinforced Concrete Beams. Discussion of papers by W. K. Hatt and Malverd A. Howe on tests made of reinforced concrete beams. 18000 w. Ill. Jour W Soc of Engrs—June, 1904. No. 64141 D.

Reinforced Concrete Construction in a Factory Extension at Bayonne, N. J. An illustrated description of extensions made to the factory of the Pacific Coast Borax Company, describing the work. 4400 w. Eng Rec—July 2, 1904. No. 63661.

Tests of Steel-Concrete Beams. Prof. Edgar Marburg. Read before the Am. Soc. for Test. Materials. A report of tests made under the direction of the writer. 3500 w. Eng Rec—July 9, 1904. No. 63783.

The Design of the Steel-Concrete Work of the Harvard Stadium. Lewis J. Johnson. An illustrated article discussing this work in detail. General discussion. 5 plates. 11500 w. Jour Assn of Engng Socs—June, 1904. No. 64132 C.

The Strength of Flat-Plates, with an Application to Concrete-Steel Floor Panels. S. E. Slocum. Develops a rational theory of stress distribution, involving only elementary mathematical principles, and applying the results to the case of a concrete-steel floor panel in actual use. 3500 w. Eng News—July 7, 1904. No. 63705.

See Civil Engineering, Bridges.

Steel Roads.

American Steel Roads. George E. Walsh. On the advantages, construction, cost, &c., of steel roads for city and country, and for automobile use. 2000 w. Gunton's Mag—July, 1904. No. 63618 C.

Timbers.

The Use of Inferior Timbers for Structural Purposes. From a paper read before the Nat. Lumber Mfrs. Assn., at St. Louis, by Hermann von Schrenk. Concerning the strength and lasting powers of inferior timbers, and information related. 1200 w. Eng News—July 28, 1904. No. 64152.

Tunnels.

Relining Winston Tunnel on the Chicago Great Western. An illustrated description of the work of relining with brick and concrete and building retaining walls in the cut. 1000 w. R R Gaz—July 22, 1904. No. 64032.

Underpinning.

Underpinning a High Wall with Steel Cantilever Girders. Illustrates and describes method used at Paterson, N. J., to make safe a mill injured by the severe floods of 1903. 1500 w. Eng Rec—July 16, 1904. No. 63844.

MATERIALS OF CONSTRUCTION.

Building Stones.

A Descriptive Catalogue of the Building Stones of Boston and Vicinity. W. O. Crosby and G. F. Loughlin. A study with regard to the durability and adaptability. 9000 w. Tech Qr—June, 1904. No. 63876 E.

Cement.

An Apparatus for the Direct Determination of the Specific Gravity of Cement. Daniel D. Jackson. Read before the N. Y. Sec. of the Soc. Chem. Ind. Illustration, with description of new apparatus, requiring only ten minutes to make a determination, and giving an accuracy to 0.01. 1200 w. Eng Rec—July 16, 1904. No. 63848.

Some Notes on the Boiling Test of Cement. Frederick H. Lewis. Read before the Am. Soc. for Testing Materials. Deals with advantages arising from variations in the composition of the cement. 1600 w. Eng Rec—July 2, 1904. No. 63667.

Explosives.

The Storage of Explosives in Densely Inhabited Areas. A paper by Capt. Thompson, read at the International Fire-Prevention Congress. Deals with the precautions enjoined by English law. 7000 w. Am Archt—July 23, 1904. No. 64056.

Fire-Proofing.

Fire-Resisting Materials. An illustrated article discussing the materials used in buildings and reporting the success of so treating fabrics and stage properties as to render them safe. 4000 w. Fire & Water—July 9, 1904. No. 63717.

Paints.

Results of an Investigation of the Durability of Paints for the Protection of Structural Work. Robert Job. An illustrated report of these investigations, which seem to show that fineness of pigment is of great importance in securing desirability of paint. Also discussion. 6500 w. Jour Fr Inst—July, 1904. No. 64015 D.

Slag.

Blast Furnace Slag as a Structural Material. Jos. A. Shinn. Reviews the uses that have been made of blast-furnace slag, and reports tests made of slag sand. General discussion. 6500 w. Pro Engrs' Soc of W Penn—April, 1904. No. 64130 D.

White Lead.

Contribution to Our Knowledge of White Lead and of Its Protecting Properties. Augustus H. Gill and Stanley A. Foster. A report of experimental investigations. 800 w. Tech Qr—June, 1904. No. 63874 E.

Wood Preservation.

The Preservative Treatment of Wood. Samuel P. Sadtler. Remarks on the structure and chemical composition of wood, with discussion of the methods of treatment to prevent decay, and the results. Ills. 5500 w. Tech Qr—June, 1904. No. 63873 E.

MEASUREMENT.

Curves.

Methods for Determining the Equations of Experimental Curves. A. S. Langedorf. An examination of methods of analysis, illustrating by examples. 2200 w. Jour Assn of Engng Socs—June, 1904. No. 64-133 C.

Steel Tape.

Steel Tape Measurements on the Massachusetts Boundary Line, 1886 to 1898. N. Spofford. An illustrated article describing the work and showing the operation of the devices used. 2000 w. Eng Rec—July 16, 1904. No. 63849.

Surveying.

Report on the Triangulation of Oneida Lake. Charles E. Curtis. A description of the work, the instruments used, the cost, etc. 2800 w. Trans Assn of Civ Engrs of Cornell Univ—1904. No. 63610 F.

Surveying-Instruments.

Additional Remarks on Surveying Instruments. H. D. Hoskold. Remarks on Thornton's improved miner's dial, the Grubb-Davis mine-surveying dial, and micrometer stadia-measurement. 1000 w. Trans Am Inst of Min Engrs—Feb, 1904. No. 64145.

MUNICIPAL.

Havana.

Sanitary Engineering in Havana. Chester C. Torrance. Gives a map of the city describing its former condition and the improvements made while the island was under the care of the United States; also discusses needed improvements. 6000 w. Trans Assn of Civ Engrs of Cornell Univ—1904. No. 63607 F.

Laboratories.

The Philadelphia Municipal Testing Laboratories. W. Purves Taylor. Describes the work carried out at these laboratories. 1300 w. Eng Rec—July 2, 1904. No. 63663.

Pavements.

Effect of Heat Upon Asphaltum in Paving Mixtures. F. O. Blake. Shows how easily asphalt may be ruined by overheating. 1000 w. Munic Engng—July, 1904. No. 63630 C.

The Available Paving Material. John W. Alvord. Briefly considers asphalt, wood, brick, bitulithic and stone. 3800 w. Munic Jour & Engr—July, 1904. No. 63-713 C.

Sewage.

The Nitrifying Organisms in Sewage Filters. Dr. Schultz-Schultzenstein. Translated from the German. Describes investigations, isolating and studying the nitrifying bacteria in sewage filters, and comparing them with nitrifying organisms in cultivated fields. 7800 w. Tech Qr—June, 1904. No. 63877 E.

The Purification System of the Sewerage of the City of Baden (Ueber die Reinigung Städischer Abwässer und die Reinigungsanlage der Stadt Baden). Thomas Hofer. A review of sewage purification systems, with a detailed description of the plant of the city of Baden. Two articles. 2 plates. 7000 w. Zeitschr d Oesterr Ing u Arch Ver—July 1, 8, 1904. No. 63926 D.

Sewers.

Large Relief Sewers in Brooklyn. Illustrates and describes improvements in the old sewer and the trap basin at the head of Gowanus Canal, and the construction of relief sewers. 4800 w. Eng Rec—July 16, 1904. No. 63846.

Street Sprinklers.

Automobile Street Sprinkler. Brief illustrated description of an automobile sprinkler, now in use in Paris. 800 w. Sci Am—July 30, 1904. No. 64155.

WATER SUPPLY.

Algae.

Removal of Anabaena from Reservoir Water. An account of the trouble with this species of algae at the Ludlow water supply of Springfield, Mass., and the investigations made for the purpose of eliminating the trouble. 2000 w. Eng Rec—July 2, 1904. No. 63659.

The Copper Sulphate Treatment for Algae at Elmira, N. Y. James M. Caird. An account of the treatment and the cost. 900 w. Eng News—July 14, 1904. No. 63833.

Arabia.

The Ancient Water-Tanks of Aden, Arabia. Arthur Stanley Riggs. Brief illustrated description of these interesting old reservoirs. 1100 w. Eng News—July 14, 1904. No. 63830.

Control.

The Administration and Control of the Nation's Water Supply. R. E. Middleton. Abstract of a paper read before the British Assn. of W.-Wks. Engrs., and of the discussion. Discusses the present British laws bearing on this subject, and the need of their revision. 4300 w. Jour Gas Lgt—July 5, 1904. No. 63765 A.

Dams.

Concrete Work on the New Croton Dam Extension. Illustrated description of the construction work. 2800 w. Eng Rec—July 9, 1904. No. 63780.

Rubble Concrete Dam for the Atlanta Water & Electric Power Co. Illustrated detailed description of an interesting construction. 1800 w. Eng News—July 7, 1904. No. 63703.

Filters.

Base Lines for Construction of Torresdale Filters, Philadelphia. John A. Vogelson. Describes the methods used. 1500 w. Trans Assn of Civ Engrs of Cornell Univ—1904. No. 63605 F.

Open Slow Sand Filters at Yonkers, N. Y. Illustrated detailed description of filtered water basin, gate chambers, filter beds and piping. 2500 w. Eng Rec—July 2, 1904. No. 63665.

The Lower Roxborough Preliminary Filters. P. J. A. Maignen. Reviews the various methods of filtration, giving the reasons for the preliminary filters at Philadelphia, and the principles involved, with details of construction and operation. Ills. 16000 w. Pro Engrs' Club of Philadelphia—July, 1904. No. 64128 D.

Fire-Hose Couplings.

A Suggested Standard Number-Code for Hydrant and Fire-Hose Couplings. C. E. Loetzer. Notes the difficulties to be met in establishing a uniform size, and gives a system for standardizing the existing varying sizes. 1500 w. Eng News—July 21, 1904. No. 64039.

Lynchburg, Va.

Concrete Dam and Wood-Stone Conduit for Lynchburg Water-Works. An account of steps being taken to furnish a gravity supply of better quality than the river water now used. Begins an illustrated detailed description of the dam. 3000 w. Eng Rec—July 23, 1904. Serial. 1st part. No. 64052.

Meters.

To Meter or Not to Meter. J. de Bruyn Kops. Also editorial. The facts given are based on an article by Morris Knowles, published in the *Engineering Record* of May 14, 1904. Objections are made to the conclusions reached. 3000 w. Munic Engng—July, 1904. No. 63629 C.

The Meter System in Cleveland. Edward W. Bemis. On the methods used to popularize water meters, their rapid installation, how to prevent freezing, cost, effect, &c. Ills. 4500 w. Munic Jour & Engr—July, 1904. No. 63714 C.

New York.

The Need of Prompt Action on New York's Additional Water Supply. Excerpts from remarks of Mr. Freeman in an address before the Nat. Board of Fire Underwriters, with comments on the pressing need of more water for New York City. 2000 w. Eng News—July 14, 1904. No. 63838.

Pipes.

Resistance Due to Bends in Pipes. John C. Trautwine, Jr. Reports investigations made of the resistance to the flow of water by various pipe connections. 700 w. Eng Rec—July 2, 1904. No. 63666.

Pumping Engines.

See Mechanical Engineering, Hydraulics.

Pure Water.

The Practical Definition of "Pure and Wholesome Water" and "Pollution." John C. Thresh. Read before the British Assn. of Water-Works Engrs. Also abstract of discussion. 3500 w. Jour Gas Lgt—July 12, 1904. No. 64009 A.

Reservoirs.

Concrete and Puddle Core Walls for Reservoir Embankments. William Watts. Abstract of a paper before the British Assn. of Water-Works Engrs. Discusses the use of concrete in preference to clay puddle, giving the authors recommendations; compares the cost, and describes construction. 2000 w. Eng News—June 30, 1904. No. 63588.

Jerome Park Reservoir Gatehouses and Concrete Lining. An illustrated article describing details of the gatehouses of this large New York reservoir, and of the lining of the bottom and slopes. 1800 w. Eng Rec—July 23, 1904. Serial. 1st part. No. 64054.

Waste.

Water-Waste Prevention in Great Britain. A comparison between the conditions governing water consumption in Great Britain and the United States. 3000 w. Eng News—June 30, 1904. No. 63589.

Worcester, Mass.

Water Supply at Worcester, Mass. F. A. McClure. Map, with illustrated description of the present supply, and outline of the history. 3000 w. Munic Eng—July, 1904. No. 63631 C.

WATERWAYS AND HARBORS.

Channels.

The Improvement of the St. Lawrence River Ship Channel. Reviews the work done on the channel of the St. Lawrence River between Montreal and Quebec. 1500 w. Eng News—July 28, 1904. No. 64151.

Crane.

Floating Crane of 100 Tons Capacity (Schwimmkran von 100 t Trägfähigkeit und 150 t. Probelast). Describing and illustrating an improved form of shears with trussed members as built for the harbor of Dantzig. A test load of 150 tons was applied. 2000 w. 1 plate. Zeitschr d Ver Deutscher Ing—July 2, 1904. No. 63905 D.

Dams.

Failure of Oakford Park Dam Across Brush Creek, Near Jeannette, Pennsylvania. Harrison Souder. An illustrated description of the dam and the accident, with suggestions for safer construction. General discussion. 3500 w. Pro Engrs' Club of Phila—July, 1904. No. 64127 D.

The Chesuncook Timber Dam. J. W. Tower. Illustrated description of the construction of a dam in Maine. 900 w. Eng Rec—July 16, 1904. No. 63845.

See Civil Engineering, Water Supply.

Dock Plant.

Electrical Plant at Heysham Harbor. Illustrated description of the plant at this large, new harbor built by the Midland Railway Co. In addition to arc and incandescent lighting current is supplied for the electric cranes capstans, lifts, &c. 2000 w. Elect'n, Lond—June 24, 1904. Serial. 1st part. No. 63646 A.

Docks.

The Southampton Docks and Cold Storage Plant of the London and Southwestern Railway. Illustrated detailed description of one of the finest docks in the world and one of the most complete cold-storage warehouses. 6000 w. Ry Age—July 1, 1904. No. 63718.

Dover.

Dover as a Port of Call. A brief illustrated account of the construction of a portion of the new harbor works. 2200 w. Transport—July 8, 1904. No. 64022 B.

Dredges.

Government Dredges for New York Harbor. Illustrated detailed description of two large suction sea dredges intended for deepening the channel. 1500 w. Marine Engng—July, 1904. No. 63620 C.

Heysham.

The Completion of Heysham Harbor. An illustrated article describing the final completion of this new port of the Midland Railway. 2500 w. Transport—July 8, 1904. No. 64020 B.

Panama.

Natural Conditions Affecting the Building of the Panama Canal. Gen. H. L. Abbot. A study of the data relating to the climate and rainfall of the isthmus which solve the problems of water supply and control. 3500 w. Engineering Magazine—August, 1904. No. 63971 B.

Pier.

Folkestone New Pier and Harbor Works. Illustrated description of these interesting works, recently completed. 6500 w. Engng—July 8, 1904. No. 63890 A.

ELECTRICAL ENGINEERING

COMMUNICATION.

Exchange.

New Telephone Exchange at Buda-Pest, Hungary. Joseph Hollos. An illustrated detailed description of the installation. 2200 w. Elec Wld & Engr—July 16, 1904. No. 63840.

The New Holborn Telephone Exchange. Illustrated description of the special features of an installation of the central battery system. 3000 w. Elec Rev, Lond—July 1 1904. No. 63748 A.

Printing Telegraph.

The Baudot System for Submarine Cables (Baudot betrieb in See-Kabel-leitungen). Describing the application of the Baudot printing telegraph apparatus to the cable between Marseilles and Algiers.

3000 w. Elektrotech Zeitschr—June 30, 1904. No. 63960 B.

Space Telegraphy.

The Distribution of Time by Wireless Telegraphy (Sur la Distribution de l'Heure à Distance au Moyen de la Telegraphie Electrique sans Fil). G. Bigourdan. Describing successful experiments in the distribution of timed impulses through space by electric discharges, made at Paris. 1000 w. Comptes Rendus—June 27, 1904. No. 63921 D.

The Rochefort System of Wireless Telegraphy. A. Frederick Collins. Illustrated detailed description. 2500 w. Elec Wld & Engr—July 16, 1904. No. 63842.

The Spark System of the Wireless Telegraph Company (Das System Telefunken der Gesellschaft für Drahtlose Telegraphie). H. Pfitzner. A description of the improved apparatus of the company controlling the united Slaby-Arco and Braun Systems. 5000 w. Elektrotech Zeitschr—June 23, 1904. No. 63956 B.

Telephony.

Storage Battery Records in Telephone Practice. Howard S. Knowlton. Gives an example of weekly battery record, showing its advantages. 1200 w. Elec Wld & Engr—July 23, 1904. No. 64045.

The Telephone in the United States. Herbert Laws Webb. On the extensive development of the service the methods, rates, with review of the progress. 6000 w. Cassier's Mag—July, 1904. No. 63869 B.

DISTRIBUTION.

Conductors.

Aluminum Electrical Conductors. Roderick J. Parke. Abstract of a paper before the Can. Elec. Assn. States the advantages and disadvantages of aluminum, discussing joints, sag, &c. 3300 w. Elec Rev, N. Y.—July 2, 1904. No. 63715.

Aluminum Electrical Conductors. Roderick J. Parke. Summary of a paper before the Can. Elec Assn. Reviews the advantages and disadvantages of aluminum. 4900 w. Can Engr—July, 1904. No. 63852.

Converters.

Operation of Synchronous Converters. S. C. Lindsay. History of the experience with 60-cycle synchronous converters in Seattle during the last three years and a half. 2500 w. Trans Am Inst of Elec Engrs—June, 1904. No. 64111 D.

Earthing.

Earthing Arrangements and Leakage Indicating Devices. Considers every-day practice, particularly in connection with three-wire distribution systems. 1300 w. Elec Engr, Lond—July 8, 1904. No. 63-888 A.

Fuse Plugs.

Supplement to the Report of the Commission on Standard Fuse Plugs with Edison Screw Threads (Erläuterungen zu den Vorschlägen der Kommission für Installationsmaterial). W. Klement. An explanation of the proposed standard fuse plugs to fit Edison lamp sockets. 3000 w. Elektrotech Zeitschr—June 16, 1904. No. 63954 B.

Polyphase Circuits.

On Pressure Variations in Polyphase Circuits. W. R. Kelsey. On the maintenance of balance with interconnected two-phase and with three-phase systems. 1600 w. Elec Engr, Lond—June 24, 1904. No. 63644 A.

Sub-Stations.

Polyphase Sub-Stations: Their Equipment and Working. S. L. Pearce. Deals with various types of sub-station equipments, considering some practical points which have arisen in connection with their working. 5400 w. Elec Engr, Lond —July 8, 1904. Serial. 1st part. No. 63887 A.

Switchboard.

See Electrical Engineering, Generating Stations.

Three-Wire.

A Three-Wire, 500-Volt Lighting System. Walter I. Barnes. Abstract of a paper read before the Boston convention of the Nat. Elec. Lgt. Assn. Describes the installation of the Narragansett Electric Lighting Company. 2000 w. Am. Elect'n—July, 1904. No. 63678.

Wiring.

Some Actual Results Obtained During the Use of Various Electric Wiring Systems. Discusses Metal tubing, wood casing, &c. 800 w. Elec Engr, Lond—July 15, 1904. No. 64084 A.

ELECTRO-CHEMISTRY.

Accumulators.

A Contribution to the Theory of the Jungner-Edison Accumulator with Constant Electrolyte. M. U. Schoop. An account of an investigation of the concentration changes and diffusion phenomena in the alkaline with constant electrolytic or "oxygen lifts cell." Also editorial. 7000 w. Elec Chem Ind—July, 1904. Serial. 1st part. No. 63734 C.

The Edison Storage Battery. An illustrated detailed description, stating the conditions Mr. Edison has aimed to fulfill. 5600 w. Engng—July 1, 1904. No. 63-756 A.

The Origin and Development of Storage Batteries. E. B. Walker. Read before the Can. Elec. Assn. Reviews the history and considers those batteries which show improvements, or departure from standard practice; also diseases of batteries, applications, &c. 5000 w. Can Engr—July, 1904. No. 63851.

Alloys.

The Electrolytic Process of Refining Gold Alloys. Emil Wohlwill. States the conditions where the electrolytic process may be applied to part gold alloys, describing treatment, methods, &c., and the applications. 4000 w. Elec-Chem Ind—July, 1904. No. 63731 C.

Anodes.

Dimensions of the Films on Aluminum Anodes. William Roy Mott. Investigation of the thickness of the film. 3000 w. Elec-Chem Ind—July, 1904. No. 63733 C.

Convention.

The Bonn Meeting of the German Society of Electro-Chemists. John B. C. Kershaw. Brief review of the papers and discussions which attracted attention. 2500 w. Elec Rev, Lond—June 24, 1904. No. 63645 A.

Electric Smelting.

See Mining and Metallurgy, Iron and Steel.

Graphite.

Adaptability of Artificial Graphite Articles. C. L. Collins. Facts concerning what has been accomplished in regular commercial work, including figures covering exact costs. Ills. 2500 w. Elec-Chem Ind—July, 1904. No. 63735 C.

Laboratory.

The Electro-chemical Laboratory of the Massachusetts Institute of Technology. Prof. H. M. Goodwin. Illustrated description of the essential features of the equipment and arrangements. 2200 w. Elec-Chem Ind—July, 1904. No. 63732 C.

Methods.

Recent Electro-Chemical Methods. J. W. Richards. Notes progress in electrometallurgy. 1000 w. Eng & Min Jour—July 21, 1904. No. 64028.

Tin Scrap.

Electrolytic Methods of Treating Tin Scrap. Gives details of all the processes which have attained industrial trial, with remarks upon costs. 3000 w. Engr, Lond—July 1, 1904. No. 63760 A.

ELECTRO-PHYSICS.

Ageing.

Experiments on the Ageing of Sheet Iron for Dynamos (Alterungsversuche an Dynamo blechen). J. Epstein, G. Stern, B. Soschinski. Tabulated results of experiments of several German manufacturers. 2000 w. Elektrotech Zeitschr—June 16, 1904. No. 63953 B.

Condensers.

High-Pressure Condensers (Ueber Hochspannungs-Kondensatoren). J. Moscicki. A long study of condenser construction for commercial purposes, with data and results of experiments on dielectrics, and upon the nature and extent of the losses. Two articles. 10000 w. Elektrotech Zeitschr—June 23, 30, 1904. No. 63957 each B.

Electrostatics.

The Electrostatic Capacity of Wires. George D. Shepardson. Considers the capacity in some of the more important cases of electrical conductors. 2200 w. Engrs' Soc, Univ of Minn—Year Book, 1904. No. 64106 D.

Radio-activity.

Atmospheric Radio-activity. H. A. Bumstead. Describes experimental investigations. 3500 w. Am Jour of Sci—July, 1904. No. 63613 D.

The Theory of Electrons and Radioactivity (Elektrorientheorie und Radioaktivität). Dr. Clemens Schaefer. A discussion of the emanations of radioactive substances, and their influence upon the theories of physics and chemistry. 4000 w. Zeitschr d Ver Deutscher Ing—July 2, 1904. No. 63906 D.

GENERATING STATIONS.

Alternators.

Self-Exciting and Compounded Alternators. Gives illustrated particulars of recent machines of this class. 1500 w. Elect'n, Lond—July 15, 1904. No. 64086 A.

The Voltage Drop of Alternators. Dr. H. Behn-Eschenburg. Abstract translation from the *Elektrotechnische Zeitschrift*. Suggests a simple correction of a method in general use for the predetermination of alternator voltage drop. 1800 w. Elec Engr, Lond—June 24, 1904. No. 63643 A.

Deflection.

The Deflection of Dynamo Frames (Die Durchbiegung von Dynamogehaüsen). F. Niethammer. A brief examination of the effects of flexure of the shaft and frame of a dynamo upon the electrical conditions. 600 w. Zeitschr f Elektrotechnik—June 19, 1904. No. 63962 D.

Discussion.

Discussion on "Contribution to Theory of the Regulation of Alternators" and "The Mechanical Construction of Revolving-Field Alternators." The first paper was by H. M. Hobart and F. Punga; the second by David B. Rushmore. 5200 w. Trans Am Inst of Elec Engrs—June, 1904. No. 64109 D.

Exposition.

The Westinghouse Power Plant at the St. Louis Exhibition. Illustrations of the fine electric-generating sets for supplying current needed in the Exhibition, with interesting particulars. 1700 w. Engng—July 15, 1904. No. 64092 A.

Hydro-Electric.

A Mexican Hydro-Electric Plant and Power Transmission. Robert McF. Doble. A well-illustrated account of the Guanajuato power station and the 100-mile, 60,000-volt transmission line. 4000 w. Engineering Magazine—August, 1904. No. 63973 B.

Hydro-Electric Power Development at and Near Joliet, Ill., Using Chicago Drainage Canal Water. Thomas T. Johnston. A discussion of the value of the water-power of this canal, the cost of development, &c. A criticism of this public work, with replies from Isham Randolph and G. M. Wisner. 12400 w. Jour W Soc of Engrs—June, 1904. No. 64142 D.

Hydro-Electric Power Installation in Iyo, Japan. Brief illustrated description. 900 w. Elec Wld & Engr—July 9, 1904. No. 63785.

The Catawba River Power Development Near Rock Hill, S. C. C. A. Mees. Illustrated detailed description of this recently completed plant. 2800 w. Eng Rec—July 23, 1904. Serial. 1st part. No. 64055.

The Hydro-Electric Power Development on the Catawba River, Near Rock Hill, S. C. Illustrates and describes one of the most interesting and complete hydro-electric developments in the South, installed to supply power within a radius of 18 miles. 2000 w. Elec Wld & Engr—July 23, 1904. No. 64043.

The Kern River Company's Hydro-Electric Power Enterprise. Burr Bassell. Brief illustrated description of a large power plant in California, the power to be transmitted 120 miles to Los Angeles. 900 w. Eng News—July 21, 1904. No. 64034.

Niagara.

The Toronto and Niagara Power Development. K. L. Aitken. Read before the Can. Elec. Assn. A detailed description of this power plant and its construction. 3800 w. Can Engr—July, 1904. No. 63855.

The Utilization of Niagara Power. H. W. Buck. An outline of the present status of the Niagara Falls Power Co. system, giving illustrated descriptions of the plants, and reporting the principal applications made of the power generated. 3500 w. Jour Assn of Engng Socs—June, 1904. No. 64134 C.

Paris.

A Large Parisian Electric Generating Plant. Francis Paul. Illustrated detailed description of the Moulineaux power station in Paris. 2500 w. Am Elect'n—July, 1904. No. 63676.

Switchboard.

The Larks Switchboard at the St. Louis Exposition. Illustrated description. 1000 w. Elec Wld & Engr—July 2, 1904. No. 63696.

Tariffs.

The Tariff Question Again (Nochmals die Tariffrage). Dr. Rasch. A discussion of the proper division of the charges for electricity supply. 2000 w. Elektrotech Zeitschr—June 23, 1904. No. 63958 B.

Transformers.

Iron Losses in Loaded Transformers. Dr. E. S. Johonnott. Offers an explantaion of the apparent diminution in the iron losses with increased load in the secondary. Also determines the magnitude of the exciting current and its phase with reference to the induction. Diagrams. 3500 w. Elec Wld & Engr—July 2, 1904. No. 63694.

On the Parallel Working of Delta- and Star-Connected Three-Phase Transformers. A. E. Kennelly and S. E. Whiting. Shows that it is not possible to parallel the secondaries of three-phase transformers when the transformation is delta-to-star or star-to-delta in one set, and delta-to-delta or star-to-star in the other. A study of phase transformation. 1200 w. Elec Wld & Engr—July 9, 1904. No. 63786.

Two-Phase.

The New Two-Phase Station at Sheffield. Illustrated description, the arrangement of the boilers and their furnaces, a regenerative system of induced draught, being of special interest. 3500 w. Elect'n, Lond—July 8, 1904. No. 63889 A.

See also Street and Electric Railways.

LIGHTING.

Arcs.

A. C. *vs.* D. C. Arc Systems. W. L. McFarlane. Read before the Can. Elec. Assn. Considers the relative costs and advantages of the different systems. 4800 w. Can Elec News—July, 1904. No. 64016.

The Bremer Light (Bremer Licht). Ernst Wagmüller. A description of the Bremer arc light, in which the carbons are impregnated with metallic salts, and arranged in an inclined position, the arc being formed below. 1800 w. Zeitschr d Ver Deutscher Ing—July 2, 1904. No. 63908 D.

Lamps.

Life of Incandescent Lamps. C. A. B. Garrett. Discusses results obtained in a series of tests under ordinary working conditions. 1200 w. Elec Engr, Lond—July 1, 1904. No. 63745 A.

The Manufacture of Incandescent Lamps at the World's Fair, St. Louis. Illustrated description of this interesting exhibit. 2200 w. Elec Rev, N. Y.—July 23, 1904. No. 64046.

MEASUREMENT.

Electrical Measurement.

Electrical Measurements at the National Bureau of Standards. Morton Githens Lloyd. A detailed account of the work of this bureau. Ills. 9700 w. Pro Engrs' Soc of W Penn—Oct., 1903. No. 63865 D.

Insulation.

The Measurement of Insulation by Means of the Electrostatic Voltmeter (Isolationsmessung mittels des Elektrostatischen Voltmeters). Dr. J. Sahulka. Describing the application of the Siemens electrostatic method to the measurement of the insulation resistance of long cables. 2500 w. Elektrotech Zeitschr—June 30, 1904. No. 63959 B.

Meter Department.

The Organization and Management of a Central Station Meter Department. A. J. Cridge. Outlines some of the methods adopted in the equipment, maintenance and working of a meter department in connection with an electricity supply undertaking. Also discussion. 7000 w. Elec Engr. July 8, 1904. No. 63886 A.

Meter Rates.

A Proposed Method of Determining Meter Rates for the Sale of Current, with an Example from Data of a Large Steam-Driven Plant. A. M. Hunt. Read before the Pacific Coast Elec. Trans. Assn. Explains a system worked out by the writer. 1200 w. Jour of Elec—July, 1904. No. 64063 C.

Testing.

Loading Machines for Testing Purposes—Supplying Only the Losses. E. A. Regestein. Applies this method of getting full-load conditions on two direct-current machines, and two similar rotary converters. 3000 w. Elec Rev, N. Y.—July 9, 1904. No. 63787.

Some Notes on Testing. Describes some simple tests of dynamos and motors. 1200 w. Elec Engr, Lond—July 8, 1904. No. 63885 A.

Vectors.

On the Complex Product of Electromotive Force Current, and Other Vectors. Henry T. Eddy. On the multiplication of vectors, showing the differences between arithmetical and vector multiplication of two complex factors. 4000 w. Elec Wld & Engr—July 23, 1904. No. 64044.

Voltage.

Voltage Drop in Three-Phase Systems. W. W. Wood. Gives a quick method of calculating the voltage drop in three-phase conductors, applicable whether the system is star or mesh connected. 500 w. Elec Engr—July 15, 1904. No. 64082 A.

Voltmeters.

Standardizing the Voltmeter. George T. Hanchett. Describes an arrangement of instruments, and method of determining the accuracy of a station voltmeter at small cost. 1300 w. Cent Sta—July, 1904. No. 63790.

MOTORS.

Magnets.

Long Stroke Electro-Magnets for Industrial Purposes (Electro-Aimants Industriels à Longue Course). R. Bérard. Describing various forms of electro-magnets and solenoids suitable for actuating signals, and operating brakes, etc. 5000 w. Mem Soc Ing Civ de France—Feb., 1904. No. 63935 G.

Motor Diagrams.

Practical Applications of the Circle Diagram to the Induction Motor (Anleitung zum Praktischen Gebrauch des den Primären Spannungs und Stromverlust Berücksichtigenden Diagramms des Drehstrommotors). Friedrich Besig. Solutions of practical problems by use of the Heyland diagram. 3000 w. Zeitschr f Elektrotechnik—July 10, 1904. No. 63965 D.

The Induction Motor Diagram. W. Parker. Diagram with description, which shows not only the phases and magnitudes of the rotor and stator currents, but also the various fluxes operating in the motor. 1600 w. Elec Rev, Lond—July 1, 1904. No. 63749 A.

Regulation.

Pole Changing in Induction Motors (Polumschaltung von Drehstrommotoren). J. K. Sumec. An examination of the method of regulating the rotative speed of induction motors by varying the magnetic field. 2500 w. Zeitschr f Elektrotechnik—June 26, 1904. No. 63964 D.

Repulsion Motors.

The Inverted Repulsion Motor. Karl Faber. An analytical and graphical study of a repulsion motor in which the rotor is connected to line and the stator short circuited. 1500 w. Elec Wld & Engr—July 16, 1904. No. 63841.

Single-Phase.

Single-Phase Power Motors for Electric-Lighting Stations. W. A. Layman. Gives the writer's views as to the proper form of alternating-current equipment for large and small plants, comparing the cost of single and polyphase motors, and discussing related matter. 3500 w. Cent Sta—July, 1904. No. 63791.

Sparking.

Discussion on "Predetermination of Sparking in Direct Current Machines" and on the "Effect of Self-Induction on Railway-Motor Commutation." The first paper was by W. L. Waters; the second by E. H. Anderson. 10800 w. Trans Am Inst of Elec Engrs—June, 1904. No. 64110 D.

Starting.

Motor Starting Switches and Resistances. F. O. Hunt. Abstract of a paper read before the Birmingham Local Sec. of the Inst. of Elec. Engrs., with discussion. Discusses quantities affecting the working of the starter, and the lasting capabilities of the switch. 2500 w. Elect'n, Lond—July 15, 1904. No. 64087 A.

TRANSMISSION.

Cables.

The Breaking Down Strength of Cables (Die Durchschlagspannung von Kabeln). Dr. Hubert Kath. An examination of the electrical pressures required to break down the insulation of cables, showing the influence of the length of the cable. 5000 w. Elektrotech Zeitschr—July 7, 1904. No. 63961 B.

Economy.

Transmission of Power versus Shipment of Fuel. A. J. Bowie, Jr. Read before the Pacific Coast Elec. Trans. Assn. Gives figures on the relative values of the two plans for a large power transmission scheme. 1000 w. Jour of Elec—July, 1904. No. 64064 C.

Lines.

Medium-Span Line Construction. Clem. A. Copeland. Read before the Pacific Coast Elec. Trans. Assn. Discusses line construction, giving experience with various cables, and stating the importance of studying carefully the conditions. Ills. 3500 w. Jour of Elec—July, 1904. No. 64066 C.

Peru.

A Peruvian High-Voltage Transmission Plant. A. L. Kenyon. Brief illustrated description of the highest voltage long-distance transmission plant in South America. 1000 w. Elec Wld & Engr—July 2, 1904. No. 63693.

Regulator.

The Regulation of Transmission Lines. J. A. Lighthipe. Read before the Pacific Coast Elec. Trans. Assn. Illustrates and describes the Tirrill regulator and its working, and the Bristol recording device. 1100 w. Jour of Elec—July, 1904. No. 64067 C.

Single Phase.

Possibilities of Single-Phase Currents in Electric Power Transmission. H. A. Bullard and Sidney Sprout. Read before the Pacific Coast Elec. Trans. Assn. Shows various advantages in favor of single-phase transmission. 3000 w. Jour of Elec—July, 1904. No. 64065 C.

MISCELLANY.

Applications.

Some Recent Applications of Electricity on a Small Scale. Howard S. Knowlton. Describes its use in the photographic dark room, in exploring lights, electric bells on cars, and numerous other fields. 1800 w. Elec, N. Y.—July 6, 1904. No. 63619.

Education.

The Electrotechnical Institute at Vienna (Das Neue Elektrotechnische Institut in Wien). A general description of the establishment and its electrical equipment. 6000 w. Elektrotech Zeitschr—June 16, 1904. No. 63955 B.

GAS WORKS ENGINEERING

Burners.

A New Burner with Forced Draught. A. Lecomte. Read at meeting of the Société Technique. Explains method adopted for increasing the light of the mantle, describing the new lamp, and claiming this new type effects an economy of from 35 to 50 per cent. as compared with ordinary incandescent burners. 1800 w. Jour Gas Lgt—June 21, 1904. No. 63752 A.

I. An Incandescent Burner (for Warm Air) Which Can Be Easily Cleaned. M. Jouanne. II. An Inverted Incandescent Burner. M. Sellié. Abstract translations of two papers presented at the Congress of the Société Technique du Gaz en France, with illustrations. 500 w. Jour Gas Lgt—June 28, 1904. No. 63742 A.

Candle-power.

Low Candle-Power Gas. William Henry White. Read before the Western Gas Assn. Urging a cheaper gas of good heat value, good burners, and good men for the advancement of the gas industry. General discussion. 7000 w. Pro Age—July 1, 1904. No. 63710.

Charging.

An Elevating-Charging Machine. M.

Passy. Read at meeting of the Société Technique. Illustrates and describes a new retort charger. 1100 w. Jour Gas Lgt—June 28, 1904. No. 63740 A.

Centrifugal Retort Chargers. F. H. Shelton. Describes various types of centrifugal coal projectors, and their advantages for charging coal-gas retorts. General discussion. Ill. 3000 w. Pro Age —July 1, 1904. No. 63711.

Charging-Machines at Villeurbanne (Lyons) Gas-Works. M. Boutan. Read at meeting of the Société Technique. Describes a plant worked electrically. The charge of coal is made into a sort of cartridge by enclosing it in a rigid tube, easily worked. 2200 w. Jour Gas Lgt—June 28, 1904. No. 63741 A.

Claus Plants.

Studies on the Claus Reaction. Gives results of investigations made, describing Claus plants tested in various works, and the tests made, stating results. 4000 w. Jour Gas Lgt—July 12, 1904. No. 64008 A.

Condensation.

Condensation of Solid and Liquid Particles in Suspension in Gases, Particularly in Lighting Gas. M. J. Philippard. Abstract of a paper read at meeting of the Société Technique de l'Industrie du Gaz en France. Discusses the deposition of dust in a gas, and the use of the "Cyclone" dust separator. Ills. 3800 w. Gas Wld—June 25, 1904. No. 63641 A.

Gas-Washer.

Theisen's Centrifugal Gas-Washer. Illustrates this machine, explaining the working principle of the system. 800 w. Engng—July 15, 1904. No. 64090 A.

Gas-Works.

The New Gas-Works at Nanterre, Near Paris. An illustrated detailed description. 5000 w. Jour Gas Lgt—July 12, 1904. No. 64005 A.

Hanover.

Hanover Gas-Works. An illustrated description of some of the chief features. 2800 w. Gas Wld—June 25, 1904. No. 63640 A.

The Growth of a Continental Gas-Works, Hanover. Illustrated historical sketch of this gas undertaking; also particulars about the new stoking machinery under trial. Ills. 6800 w. Jour Gas Lgt —June 28, 1904. No. 63739 A.

Illumination.

Light Measurement. Jacques Abady. A lecture delivered before the Dutch Assn. of Gas Mgrs. Hints on commercial light-testing. 5000 w. Jour Gas Lgt —July 12, 1904. No. 64007 A.

Inspection.

Gas Inspection. Ira C. Copley. Read at St. Louis meeting of Am. Gas Assn. Discusses state inspection to determine the quality and the testing of meters to assure the exact measurement, &c. 9000 w. Pro Age—July 15, 1904. No. 63805.

Management.

Notes on the Management of Gas-Works. George Helps. Discusses principally accounts and how to keep them, in the present article. 4400 w. Gas Wld—July 2, 1904. Serial. 1st part. No. 63738 A.

Photometry.

Some French Views on Photometry and Pyrometry. Abstract translations of several papers presented at a recent meeting of the Société Technique du Gaz en France. Ills. 2200 w. Jour Gas Lgt—July 5, 1904. No. 63764 A.

Progress.

Opening Address before the American Gas Associations, at St. Louis, Mo. Rollin Norris. Indicates lines along which progress is possible, such as cheaper raw materials, increased efficiency, reduced waste, &c. Brief discussion. 6000 w. Pro Age—July 15, 1904. No. 63803.

Purification.

Removing Suspended Particles from Gases. Principal portions of a paper by M. Philippard read at meeting of the Société Technique. Discusses briefly the principles of purification, investigating different types of condensers, and favoring the cyclone. 3500 w. Jour Gas Lgt —June 21, 1904. No. 63754 A.

Regulator.

The Luchaire-Lecomte Gas Regulator. M. Lecomte. Read before the Soc. Tech. du Gaz en France. Illustrates and describes a new device for regulating the consumption of gas. 1200 w. Jour Gas Lgt—July 12, 1904. No. 64006 A.

Retorts.

A Derval Setting of Retorts at the Nanterre Gas-Works. P. Parsy. Read before the Société Technique. An illustrated description of these inclined retorts and their working, explaining the simple remedy adopted to stop slipping in the retorts during carbonization. 2000 w. Jour Gas Lgt—June 21, 1904. No. 63753 A.

The Woodall-Duckham Vertical Retort. Illustrations and information from the patent specifications. 1500 w. Jour Gas Lgt—July 5, 1904. No. 63763 A.

Water Gas.

Introduction of Water Gas into Retorts in which Coal is Undergoing Carbonization. Abstract translation of a paper by Albrecht and Shirk Boyer, in *Jour. für Gasbeleuchtung.* Describes experiments made. 1700 w. Jour Gas Lgt —June 28, 1904. Serial. 1st part. No. 63743.

INDUSTRIAL ECONOMY

Costs.

Some Conditions Affecting the Costs of Manufacturing (Einige Erwägung in der Frage der Selbstkostenbestimmung). S. St. Recsei. Deriving formulas and diagrams for use in determining the costs in the manufacture of dynamos. 3500 w. Zeitschr f Elektrotechnik—June 19, 1904. No. 63963 D.

Labor.

Payment of Labor. John Magee. A brief survey of the methods used, classifying them in nine groups and considering each. 2700 w. Am Found Assn—June, 1904. No. 63590.

The Labor Question. F. H. Shelton. Read at the St. Louis meeting of the Am. Gas Assns. Discusses the subject of improvement of the relations between gas companies and their employees, reviewing what has been done in the United States and offering suggestions. Discussion. 11000 w. Pro Age—July 15, 1904. No. 63804.

Patents.

The New Patent Law. A discussion of the British Patents Act of 1902, which attempts to give inventors the benefit of an official search, and to avoid the defects of other countries. 1700 w. Engr, Lond —July 1, 1904. No. 63758 A.

Piece System.

Notes on a Successful Piece Price System. John Magee. Outlines what has proved a successful way of handling the problem in a large foundry. 800 w. Am Found Assn—June, 1904. No. 63591.

Selling.

The Organization of the Machinery Selling Department. Russel M. Seeds. A discussion of the modern methods of seeking and developing a market, considered as a department of works organization. 3000 w. Engineering Magazine—August, 1904. No. 63974 B.

Specifications.

The Influence of Specifications on Commercial Products. Review of the presidential address of Dr. Charles B. Dudley, to the American Society of Testing Materials. 2500 w. Eng Rec—July 9, 1904. No. 63782.

Trade Expenditure.

The Supervision and Control of Trade Expenditure. Describes the working of a system now in use, showing that the methods adopted have not only effected economy, but have developed rather than curtailed the business. 2700 w. Engr, Lond—July 15, 1904. No. 64096 A

Wages.

A Review of the Wage Problem. C. H. Benjamin. Outlines briefly the various systems that have been tried, discussing their merits. 5000 w. Cassier's Mag —July, 1904. No. 63871 B.

MARINE AND NAVAL ENGINEERING

Coal Endurance.

Methods of Estimating the Coal Endurance of a Naval Vessel. D. W. Taylor. Discusses the factors affecting coal consumption and considers the principal methods of obtaining approximate results. 5000 w. Eng News—July 14, 1904. No. 63837.

Coal Storage.

The Coal Storage and Coal Handling Plant at the New York Navy Yard. Jos. S. Shultz. Illustrates and describes a plant recently completed, giving information in regard to its construction and working. 3200 w. Eng News—July 21, 1904. No. 64040.

Destroyers.

Destroyers. Editorial discussion of the new torpedo-boat destroyers for the British government. 4000 w. Engng—July 8, 1904. No. 63893 A.

H. M. Torpedo-Boat Destroyer "Welland." Illustration, with brief description and report of official trials. 900 w. Engng—July 8, 1904. No. 63892 A.

Diving.

Notes on Diving Machinery (Considérations sur les Scaphandres). M. Dibos. A discussion of recent forms of diving suits and apparatus for wrecking, and for submarine work generally. 3500 w. Mem Soc Ing Civ de France—March, 1904. No. 63937 G.

Excursion Steamer.

Handsome Excursion Steamer. Illustrated description of the Old Colony, built for the Boston and Plymouth route. 1000 w. Naut Gaz—July 14, 1904. No. 63792.

Fire Protection.

Fire Protection for Steam Vessels and Government Regulations. J. H. Morrison. Reviews the fire equipment of steamboats from the earliest vessels. 1500 w. Sci Am Sup—July 16, 1904. No. 63808.

Fleets.

Steaming Powers of the Russian and Japanese Fleets. Gives interesting particulars in regard to the vessels of both fleets; their present condition, how they have fared, &c. 1500 w. Engr, Lond—July 15, 1904. No. 64100 A.

Liners.

Launch of the Cunard Liner Caronia. Two illustrations with detailed description of the largest ship thus far built on the Clyde. 2000 w. Engr, Lond—July 15, 1904. No. 64099 A.

The New Cunard Flyers. Albert G. Hood, in the Mid-Tyne Link. Brief review of the growth in size of vessels used to navigate the Atlantic. Diagrams. 2000 w. Marine Rev—July 28, 1904. No. 64159.

The New Cunard Liner "Caronia." Illustrated detailed description of this very large ship. 1800 w. Engng—July 15, 1904. No. 64095 A.

The New White Star Liner "Baltic"—the Largest Vessel in the World. Brief illustrated description, with account of the maiden trip. 1100 w. Sci Am—July 16, 1904. No. 63807.

Motor Boat.

Motor Boating. Illustrates and describes the powerful petrol racing launch being built for Lord Howard de Walden. 1200 w. Auto Jour—July 16, 1904. No. 64078 A.

Remarkable Naphtha Boat John Chamberlin. Brief description, with illustrations, of a novel experimental boat. 700 w. Marine Rev—July 21, 1904. No. 64041.

Some Experiments on an Uncooled Petrol Motor. L. H. Callendar. Summary of experiments made to test these motors, describing methods and apparatus used. 7000 w. Sci Am Sup—July 30, 1904. No. 64157.

Navy Yard.

Electricity at the Washington Navy Yard. J. E. Price. An illustrated article giving information of the electric outfitting of the various shops. 1100 w. Elec Rev, N. Y.—July 16, 1904. No. 63839.

Revenue Cutter.

Trial of the United States Revenue Cutter Mohawk. Description of the vessel and its equipment, with report of the contract trial. 1800 w. Marine Engng—July, 1904. No. 63622 C.

Torpedo Boat.

A Turbine-Driven Torpedo-Boat. Reports an unofficial trial of a boat built by Messrs. Yarrow & Co., describing the vessel and its equipment. 700 w. Engng—July 15, 1904. No. 64094 A.

Torpedo Tubes.

The Submarine Torpedo Tube. Illustrates and describes a torpedo-tube of the type used on the battleship "Maine," the room below the protective deck, and the operation of firing. 1200 w. Sci Am—July 9, 1904. No. 63728.

Warships.

Progress of Warships and Machinery Building in England. A record of the work in these fields during the last half year. 2500 w. Engr, Lond—July 8, 1904. No. 63896 A.

MECHANICAL ENGINEERING

AUTOMOBILES.

Benz.

The Possibilities of the Belt-Driven Benz. R. W. Buttemer. Illustrates and describes some improvements made in these cars. 2000 w. Autocar—July 2, 1904. No. 63737 A.

Carburetter.

See Mechanical Engineering, Internal-Combustion Motors.

Gasoline Car.

Design for a Light Gasoline Car. J. C. Brocksmith. Working drawings and description of a gasoline automobile of light and simple construction. 2700 w. Am Elect'n—July, 1904. No. 63679.

Holson Motor.

A New Four-Wheel Drive Freight Truck. Corneil Ridderhof. An illustrated description of a vehicle equipped with the Holson couple-gear motor. 800 w. Mach, N. Y.—July, 1904. No. 63690 C.

Hutton.

The Hutton Car. Description, drawings and illustrations of a car aiming to bring the least possible strain upon the driver, enabling concentration on the steering-wheel. 3600 w. Engng—June 24, 1904. No. 63648 A.

Light Cars.

The Clement-Talbot Cars. Illustrated description of these light cars, remarkable for their silence and ease of control, great flexibility of engine and power in proportion to weight. 1200 w. Autocar—July 2, 1904. No. 63736 A.

Mercedes.

The Latest Mercedes Model—The 28-32 H. P. Car. Illustrations and particulars of this type, showing the improvements in design. 2500 w. Auto Jour—July 9, 1904. No. 63880 A.

Motive Power.

Motive Power for Automobiles. Prof. R. C. Carpenter. From a paper read before the Am. Motor League, in New York. Reviews briefly the motive power at present used, considering the gas engine the most economical and convenient means of propulsion. 2200 w. Automobile—July 23, 1904. No. 64042.

Motor Cars.

Motor Cars on European Railways. Illustrates and describes some of the recent motor cars and motor-car services of European railways. 6800 w. Eng News—July 28, 1904. No. 64150.

Mountain Trip.

3,000 Kilometres by Motor Car Over the Alps. An illustrated account of an interesting trip made in a Martini car. 2800 w. Auto Jour—July 16, 1904. No. 64077 A.

Pumps.

Water Circulating Pumps. F. Strickland. Describes the types used at different times in automobiles, suggesting improvements. Ills. 1000 w. Autocar—June 25, 1904. No. 63634 A.

Road Trains.

Automobile Road Trains. Daniel Bellet. Illustrations and brief description of trains devised by Col. Charles Renard. 900 w. Trac & Trans—July, 1904. No. 64004 E.

Tyres.

Remarkable Tyre-Bursting Demonstration. An account of an interesting demonstration given by S. E. Edge at the Crystal Palace to show that bursting tyres are not as disastrous as claimed. Ills. 700 w. Autocar—July 16, 1904. No. 64075 A.

Variable Gears.

The "Hall" Hydraulic Variable Speed-Gear. Illustrated description of a form of gear in which a hydraulic system, using oil as the fluid medium, is employed. 3300 w. Auto Jour—June 25, 1904. Serial. 1st part. No. 63633 A.

HEATING AND COOLING.

Hot Water.

A Central Hot-Water Heating Plant in the Boston Navy Yard. Describes an installation of the Evans exhaust hot-water heating system with forced circulation, and its working. Ills. 4500 w. Eng Rec—July 16, 1904. No. 63847.

Ventilation.

Notes on the Plenum System of Ventilation. William Henman. Also discussion. Showing that this system can be beneficially employed in certain buildings. 16000 w. Jour Roy Inst of Brit Archts—June 11, 1904. No. 63612 B.

Warm Air.

Advanced Methods of Warm Air Heating. A. C. Jones. Read before the Am. Soc. of Heat. & Ven. Engrs. Illustrates and describes a system, giving a plan of a residence which is heated with a warm air furnace, where seven supply pipes are used for heating thirteen rooms. 1800 w. Met Work—July 16, 1904. No. 63789.

HYDRAULICS.

Air Lifts.

Air-Lift Pumping Plant at Birkenhead. J. W. M. Richardson. Abstract of a paper read before the British Assn. of Water-Works Engrs. and of the discussion thereon. Describes a plant put down to increase the water supply, giving particulars of the cost of working. 4200 w. Jour of Gas Lgt—July 19, 1904. No. 64138 A.

Raising Water by Compressed Air. C. T. Alfred Hanssen. Explains the theory of the air-lift pump, the conditions of maximum efficiency, &c. Ills. 4000 w. Engng Rev—July, 1904. No. 64014 B.

Centrifugal Pumps.

High-Lift Turbine Pumps. Illustrates and describes an electrically driven pump of this type, of very good efficiency. 900 w. Engng—June 24, 1904. No. 63649 A.

High-Pressure Centrifugal Pumps (Hochdruck Kreiselpumpen). H. Dubbel. Illustrating and describing centrifugal pumps arranged to operate in series at high rotative speeds to pump against heads of several hundred metres. 2000 w. Zeitschr de Ver Deutscher Ing—July 2, 1904. No. 63907 D.

High-Pressure Centrifugal Pumps (Pompe Centrifuge à Haute Pression). K. Sosnowski. A description of the de Laval system, using small runners connected directly to a steam turbine. 2500 w. Mem Soc Ing Civ de France—Feb., 1904. No. 63936 G.

The Rateau High Pressure Centrifugal Pumps and Blowers (Hochdruck Kreiselpumpen und Hochdruckventilatoren System A. Rateau). Julius Divis. Describing the series arrangement of runners designed for direct connection to the steam turbine for pumping or blowing against high pressures. Three articles. 1 plate. 6000 w. Oesterr Zeitschr f Berg u Hüttenweser—June 25, July 2, 9, 1904. No. 63943 each D.

High Pressure.

High Pressure Hydraulic Distribution of Power with Special Reference to Elevator Machinery. H. D. James. Presents the advantages of water power at high pressure, its applications, &c., discussing its advantages and disadvantages as a power for elevators. General discussion. 7000 w. Pro Engrs Soc of W Penn—April, 1904. No. 64131 D.

Pumping Engines.

Pumping Engines at Hinksford. Illustrated description of these engines with results of official tests. 1800 w. Engr, Lond—July 8, 1904. No. 63898 A.

Working Costs of Water-Works Pumping-Engines. A. H. Meysey-Thompson and H. Lupton. Abstract of a paper before the British Assn. of Water-Works Engrs., and of the discussion. Considers four main types of pumping-engine. 3000 w. Jour Gas Lgt—June 21, 1904. No. 63755 A.

Turbines.

The Reversibility of Hydraulic Turbines (Sur la Réversibilité des Turbo-Machines Hydrauliques). Platon Yankowsky. A study of turbine water-wheels and centrifugal pumps showing the manner in which they are related to each other. 12000 w. Revue de Mécanique—May 31, 1904. No. 63928 E + F.

Water-Power.

An Unusual Water-Power Plant at Kykkelsrud, Norway. Illustrates and describes the development of an unusually interesting water-power plant, comprising dams, an open canal, and a power house, the hydraulic works, &c. 3000 w. Eng Rec—July 2, 1904. No. 63662.

INTERNAL-COMBUSTION MOTORS.

Carburetter.

The Claudel Carburetter (Le Carburateur Claudel). H. Claudel. A study of the general theory of carburetting air with the vapor of liquid fuels for internal combustion motors, and a description of the author's apparatus. 4000 w. Mem Soc Ing Civ de France—March, 1904. No. 63938 G.

Combustion.

The Chemistry of Combustion. An explanation of the chemistry of the petrol engine. 1600 w. Autocar—July 9, 1904. No. 63878 A.

Diesel.

The Diesel Engine. W. H. Booth. An account of a commercial test made of a Diesel engine when driving electric generators. 2800 w. Engr, U S A—July 15, 1904. No. 63864 C.

Gas Engines.

The Bollinckx Gas Engine and Producer. A. H. Allen. Illustrates and describes particulars of a modern design of this engine. 1200 w. Engr, U S A—July 1, 1904. No. 63671 C.

Petrol Turbine.

A New Petrol Turbine. Illustrates and describes a design for an internal combustion turbine motor. 1000 w. Autocar—July 16, 1904. No. 64076 A.

MACHINE WORKS AND FOUNDRIES.

Ball Bearings.

The Theory of Ball Bearings (Sur les Roulements à Billes). L. Lecornu. An examination of the formulas of Léauté and Bousshinesq, for computing the frictional resistance of ball bearings. 2000 w. Revue de Mécanique—May 31, 1904. No. 63929 E + F.

Belt Machine.

The Hyatt-Belt Fabric Stitching-Machine. Illustrated description of a machine for the making of belts, rugs, carpets, &c. Describes its action. 1600 w. Engng—July 15, 1904. No. 64091 A.

Castings.

Direct Casting from the Blast Furnace. An account of the revival of an old practice, with very considerable improvements, in Northamptonshire, by which a portion of the make of the furnaces is converted into castings, describing the arrangements. 1800 w. Engr, Lond—July 1, 1904. No. 63759 A.

Spongy Brass Castings. C. Vickers. Discusses the cause of the trouble. 2000 w. Am Mach—July 7, 1904. No. 63683.

Making Castings in Aluminum. Walter J. May. Calls attention to points that are of importance to ensure successful work. 1200 w. Prac Engr—July 15, 1904. No. 64079 A.

Cores.

A Plea for the Coremaker. Alex. T. Neil. Considers some of the troubles in core-making. Ills. 1000 w. Am Found Assn—June, 1904. No. 63593.

Core Making Machines (Kernformmaschinen). Oskar Leyde. Illustrating a number of machines, mainly of German design. 1500 w. Zeitschr d Ver Deutscher Ing—July 9, 1904. No. 63911 D.

The Core Bench. Benjamin D. Fuller. Discusses the essentials of good core work in the economical production of castings. 700 w. Am Found Assn—June, 1904. No. 63592.

Cranes.

Foreign Types of Steam and Electric Harbor Cranes. Frank C. Perkins. Illustrated detailed descriptions of electric cranes for dock work. 2300 w. Marine Engng—July, 1904. No. 63621 C.

The Electrical Equipment of Overhead

Travelling Cranes. J. W. Warr. An illustrated description of a crane with separate motors for each motion, the wiring and fitting. 900 w. Elec Rev, Lond—July 15, 1904. No. 64085 A.

Cupolas.

Investigations of the Blowing of Foundry Cupolas. Abstract of a paper by W. H. Carrier, giving results of investigations made by the Buffalo Forge Co., with comments. 2500 w. Eng News—July 21, 1904. No. 64038.

Elevators.

The Works of the Standard Plunger Elevator Company. W. A. Waterman. Illustrated detailed description of these works, located at Worcester, Mass. Also details of the elevator manufactured. 3800 w. Mach, N. Y.—July, 1904. No. 63691 C.

Foundries.

Foundry Accounting. Kenneth Falconer. Describes a foundry "cost system" representing a part of a complete system designed for large brass works, with remarks on the subject in general. 1500 w. Am Found Assn—June, 1904. No. 63597.

Lincoln Plant of the United Engineering & Foundry Co., at Pittsburg. An illustrated description of one of the largest plants for the manufacture of rolls for the working of iron and steel. 2500 w. Ir Trd Rev—July 7, 1904. No. 63777.

Some Labor-Saving Suggestions for the Foundry. H. F. Frohman. Calls attention to devices found useful in the foundry. 1000 w. Am Found Assn—June, 1904. No. 63594.

The Iron Foundry of Bopp & Reuther at Waldhof, near Mannheim (Die Eisengiesserei der Firma Bopp & Reuther in Waldhof bei Mannheim). Illustrated description of a recent German foundry, arranged for electric driving and machine moulding. 2500 w. 1 plate. Stahl u Eisen—June 15, 1904. No. 63949 D.

Gauge.

Inspirator Valve Gauge. L. C. Hitchcock. Description and sketch of a gauge made in the shops of the Northern Pacific Ry. Co. 900 w. Loc Engng—July, 1904. No. 63723 C.

Green-Sand.

Standard and Systematic Methods for Making Beds. Thomas D. West. An illustrated article giving the results of the writer's experience and investigations in making green sand beds. 5000 w. Am Found Assn—June, 1904. No. 63598.

Grinder.

The Walker Tool Room Grinder No. 2. Illustrates and describes a tool intended for cutter-grinding, but also used for grinding miscellaneous work. 2200 w. Ir Age—June 28, 1904. No. 64148.

Jigs.

Jig Making. Frank E. Shailor. Discusses methods of accurately spacing the holes. Ills. 1800 w. Mach, N. Y.—July, 1904. No. 63692 C.

Laboratory.

The Value of the Chemist and Metallurgist to a Manufacturing Plant. H. C. Loudenbeck. On the value of a chemical laboratory with hints in regard to its practical application to the work. 1400 w. Am Found Assn—June, 1904. No. 63595.

Linkages.

The Generation of a Compound Curve by Three Double Linkages (Zur Erzeugung der Koppelkurve durch Drei Doppelkurbelgetriebe). Heinrich Kratzert. An examination of the kinematic theory of the three-bar linkage motion, and the curves generated by it. 3000 w. Zeitschr d Oesterr Ing u Arch Ver—July 1, 1904. No. 63927 D.

Locomotives.

Industrial Locomotives. J. F. Gairns. The present article deals with steam locomotives mainly for mining or factory use. Ills. 3500 w. Cassier's Mag—July, 1904. Serial. 1st part. No. 63870 B.

Mechanical Drawing.

A Proposed Universal Dictionary of Mechanical Drawing. George H. Follows. The first of a series of articles aiming to furnish an acceptable "drawing dictionary." Ills. 1800 w. Eng News—July 14, 1904. Serial. 1st part. No. 63832.

Molding.

Machine Molding. G. P. Campbell. The present article discusses flasks. Ills. 1800 w. Am Mach—July 28, 1904. Serial. 1st part. No. 64147.

Molding Machines and Their Use. E. H. Mumford. Abridged paper, read before the Am. Found. Assn. Remarks on some of the simpler machines. 1200 w. Am Mach—July 7, 1904. No. 63682.

Molding Machine Practice. Fred W. Hall. An illustrated article treating of the match plate method of machine molding. 2200 w. Foundry—July, 1904. No. 63632.

Patternmaking.

Patternmaking in Its Relation to Foundry Costs. W. H. Parry. Considers some of the shortcomings incident to the making of patterns. 900 w. Am Found Assn—June, 1904. No. 63596.

Patterns.

A Water Tank Column Pattern. Joseph Horner. Illustrated description.

1100 w. Am Mach—July 21, 1904. No. 64026.

System for Storing and Caring for Patterns. R. S. Chemin. Briefly considers the handling and shipping, accounting, indexing and storage of patterns. 1400 w. Am Mach—July 14, 1904. No. 63793.

Phonograph Works.

The Edison Phonograph Works, Orange, New Jersey. Remarks on the Edison phonograph display at St. Louis, and plan and description of the factory. 5500 w. Engng—June 24, 1904. No. 63647 A.

Pistons.

Making Gas-Engine Pistons. R. F. Garland. Illustrates and describes tools and methods for this work. 2400 w. Am Mach—July 14. 1904. No. 63794.

Projectiles.

High-Speed Steel and the Manufacture of Armor-Piercing Projectiles. Illustrates and describes the processes through which a shell passes in manufacture. 1700 w. Am Mach—July 7, 1904. No. 63681.

Riveting.

Electric vs. Hydraulic Cranes for Riveter Towers. Frank B. Kleinhans. Claims the electric crane to possess advantages for this work. 1500 w. Elec Wld & Engr—July 2. 1904. No. 63695.

Shop Locomotives.

Storage Battery Locomotives for Shop Transportation. J. A. McIntyre. Illustrated descriptions of exhibits at the Louisiana Purchase Exposition. 700 w. Sci Am Sup—July 16, 1904. No. 63809.

Springs.

On the Transverse Vibrations of Helical Springs. Howard L. Bronson. A study of this subject, describing apparatus and methods of investigation, giving results. 3000 w. Am Jour of Sci—July, 1904. No. 63614 D.

Tool Rooms.

The Tool Room and its Functions in Cost Reduction. John Ashford. Mr. Ashford's second paper treats of the standardizing of small tools and the study of operations in which they are used. 4500 w. Engineering Magazine—August, 1904. No. 63976 B.

Turret Lathes.

The Development of a Remarkable Turret Lathe. Illustrates and describes development of the "flat turret" for imparting to the spindle a range of speeds and to the turret slide a wide feed variation. 2500 w. Am Mach—July 28, 1904. Serial. 1st part. No. 64146.

Works.

The Pennsylvania Engineering Works. Plan and description of large works devoted to the building of blast furnace and steel plant construction, general machine and plate work, ingot molds and heavy castings. 2200 w. Ir Age—July 7, 1904. No. 63684.

MATERIALS OF CONSTRUCTION.

Carborundum.

Carborundum Firesand. T. J. Tone. On its special properties and the applications. 1200 w. Ir Trd Rev—July 21, 1904. No. 64019.

Cast-Iron.

Notes and Observations on Cast-Iron. J. E. Johnson, Jr. Considers especially the production of satisfactory castings from iron considered unsuitable by the average foundryman, giving much information of value. 4500 w. Trans Am Inst of Min Engrs—Feb., 1904. No. 64123.

The Mobility of Molecules of Cast-Iron. A. E. Outerbridge, Jr. Gives some further investigations on the behavior of cast iron, and calls attention to the effects of the Baltimore fire on this material. 1500 w. Trans Am Inst of Min Engrs—Feb., 1904. No. 64144.

Corrosion.

A New Process for the Protection of Iron and Steel from Corrosion. Sherard Cowper-Coles. Describes a new process of coating iron and steel with a thin even deposit of zinc at a temperature several hundreds of degrees below the melting point of zinc. 1800 w. Prac Engr—July 1, 1904. Serial. 1st part. No. 63744 A.

Ductility.

The Limit of Ductility (Zum Begriff "Streckgrenze"). C. Bach. A discussion of the need of a term to indicate the limit of ductility in testing materials, and a suggestion as to its correct definition and determination. 1800 w. Zeitschr d Ver Deutscher Ing—July 9, 1904. No. 63912 D.

Laboratory.

The Royal Testing Laboratory at Gross-Lichterfelde-West (Das Königliche Materialprüfungsamt zu Gross-Lichterfelde-West). An illustrated account of the new buildings to be occupied by the Royal testing laboratory and the Chemical-Technical Research Department of the Prussian Government, near Berlin. Serial. Part I. 4000 w. Zeitschr d Ver Deutscher Ing—July 9, 1904. No. 63909 D.

Lubricants.

Analyses of Lubricating Greases. P. H. Conradcon. Considers solid lubricants, and the mthods of analyzing them. 5000 w. Pro Engrs' Soc of W Penn—March, 1904. No. 63867 D.

Mineral Lubricating Oils. J. N. Bruck. A lecture before the Engrs.' Assn. of Boston. Deals with the process of refining and testing mineral oils, and the characteristics of an efficient lubricator. 2500 w. Engr, U S A—July 1, 1904. No. 63672 C.

Metals.

The Hard and Soft States in Metals. G. T. Beilby. A study of metals, explaining a new phase theory, illustrating by examples, and giving a full account of researches. General discussion. Ills. 12000 w. Elec-Chem & Met—June, 1904. No. 64104 C.

Pig Iron.

Chemical Specifications for Pig-Iron. B. F. Fackenthal, Jr. A discussion of the paper by Edgar S. Cook. 1500 w. Trans Am Inst of Min Engrs—Feb., 1904. No. 64118.

Testing.

Testing Machine of 300 Tons Capacity (Machine Universelle d'Essais de 300 Tonnes). Pierre Breuil. An account of the large testing machine made by Buckton & Co., of Leeds, for the laboratory of the Conservatoire des Arts et Métiers. 2000 w. Génie Civil—July 2, 1904. No. 63915 D.

The Testing Laboratory of the Conservatoire des Arts Et Métiers (Le Laboratoire d'Essais du Conservatoire National des Arts et Métiers). E. Leduc. With views of the various departments and an outline of the system of work. Serial. Part I. 2000 w. Revue Technique—June 25, 1904. No. 63950 D.

MEASUREMENT.

Beams.

Problems in Beams and Planes Severally Supported and Eccentrically Loaded. C. F. Blake. Remarks on the principles of the polar moment of inertia method and its applications to these problems. 1200 w. Mach, N. Y.—July, 1904. No. 63689 C.

Diagrams.

A Diagram Measurer. Describes a cheap and useful instrument—explaining its use. 1100 w. Prac Engr—July 8, 1904. No. 63882 A.

Fly Wheels.

Graphic Method for Determining the Weight of Flywheels. Diagrams are given, with explanation. 800 w. Prac Engr—July 8, 1904. No. 63881 A.

Link Motion.

Link-Motion Bench for the Technical College, Finsbury. Illustration, with description of an apparatus designed by Prof. W. E. Dalby for investigating the properties of a link motion. 1000 w. Engng—July 8, 1904. No. 63891 A.

POWER AND TRANSMISSION.

Belts.

A New Rule for Belt Calculations. States rule, illustrating by examples. 2400 w. Elec Engr, Lond—July 1904. No. 64083 A.

Compressed Air.

A Novel Air Compressor. Brief illustrated description of the invention of Henry Bland, of Sydney, Australia. 800 w. Sci Am—June 16, 1904. No. 63806.

Comparison of Costs of Compressing Air with Steam and Electricity at Rossland, British Columbia. William Thompson. Describes the steam and electric plants compared, and records their performance. 2500 w. Min Rept—July 14, 1904. No. 63859.

Packing a Compressor Piston. T. R. Wingrove. Discusses the wrong way and the right way of packing a rod. 2200 w. Ice & Refrig—July, 1904. No. 63720 C.

The Air Compressor. R. H. Collingham. Discusses the design of air compressors with the object of indicating how theoretical facts and formulæ may be made of use in the drawing-office. 1400 w. Engr, Lond—June 3, 1904. Serial. 1st part. No. 63650 A.

The Compressed Air Power Transmission Plant of the Cleveland Stone Company. Lucius I. Wightman. An illustrated detailed description of a central power plant, transmitting power by air pipe lines to various machines throughout the quarry. 6500 w. Eng News—July 7, 1904. No. 63702.

Fly Wheels.

Belt-Wheel Explosion at Mishawaka, Ind. Ira C. Boles. An illustrated account of an unexplained accident on March 31, 1904. 700 w. Power—July, 1904. No. 63688 C.

Gears.

The Solution of Problems in Spiral Gearing. E. C. Oliver. Gives a simple and accurate method for the solution of any problem in spiral gearing. 1000 w. Engrs' Soc, Univ of Minn—Year Book, 1904. No. 64107 D.

Worm Gearing. F. L. Berry. Discusses this form of speed reducer, its advantages, and the cause of bad designs, considering the factors that influence the efficiency, &c. Ills. 3500 w. Mech Engr—July 16, 1904. No. 64080 A.

Heat Motors.

The Recent Development of Heat Motors (Ueberblick über die Gegenwärtige Entwickelung der Wärmemotoren und Kraftwerke). E. Josse. A general review of the development of steam and gas engines since the Paris exposition of 1900;

including turbines and binary vapor engines. Two articles. 6000 w. Zeitschr d Ver Deutscher Ing—June 18, 25, 1904. No. 63900 each D.

Machinery.

Pumping and Air Compressing Machinery at the St. Louis Exposition. An illustrated review of exhibits showing the latest achievements in these and allied branches of engineering. 4000 w. Ir Age—July 21, 1904. Serial. 1st part. No. 64017.

Machinery Tests.

Some Tests of Iron and Woodworking Machinery. C. H. Hines. An account of tests made to determine the amount of power used by old machine tools in a shop which was to be equipped with electricity and yet retain the old machines. 3000 w. Elec Wld & Engr—July 16, 1904. No. 63843.

Mechanical Plant.

The Mechanical Plant of the Hotel Astor, New York City. An illustrated detailed description of the fine power and refrigerating plant in the latest great hotel of this city. 5200 w. Eng Rec—July 23, 1904. No. 64047.

Power Cost.

The Cost of Power in a Large Iron Works (Krafterzeugungskosten für ein Grosses Hüttenwerk). Karl Iffland. Giving an elaborate tabulation of the various elements of power cost for steam, gas, and electric driving. 10000 w. Stahl u Eisen—June 15, 1904. No. 63948 D.

Rope Driving.

Some Notes on Rope Driving. John Joseph Flather. Notes on the systems used, the materials, care, strains, speed, &c. Ills. 6000 w. Engrs' Soc, Univ of Minn—Year Book, 1904. No. 64108 D.

Speed-Varying.

Gasnier's New Electro-Mechanical Coupling and Speed-Varying Device. E. P. Buffet. Illustrates and describes an electro-mechanical method of transmission devised by Paul Gasnier. 1200 w. Am Mach—July 14, 1904. No. 63795.

STEAM ENGINEERING.

Boiler-House.

Boiler-House Economies. Abstract of a paper by Reginald S. Downe read at meeting of the Incor. Munic. Elec. Assn. Considers means of reducing the coal consumption. 4000 w. Mech Engr—July 16, 1904. No. 64081 A.

Boilers.

Butt Strap Joints for Boilers. R. S. Hale. Discusses the width and thickness of the straps. 700 w. Power—July, 1904. No. 63687 C.

Copper Tubes for Locomotive Boilers. Francis W. Webb. Abstract of a paper presented to the Inst. of Civ. Engrs., London. An account of experimental investigations made to ascertain the composition of the copper tubing most suitable for use in locomotive boilers. Ills. 1200 w. R R Gaz—July 15, 1904. No. 63797.

Ferry Works, Queensferry. An illustrated article describing details of the Niclausse boilers as manufactured at their new works. 2800 w. Engr, Lond—July 1, 1904. No. 63761 A.

Cooling Tower.

Cooling Tower and Condensing Equipment in an Atlanta Plant. Illustrations and description of a cooling tower installation designed to handle 260,000 gallons of water per hour, and a condensing equipment, including a beam-type quadruple expansion pump. 1700 w. Eng Rec—July 9, 1904. No. 63784.

Explosion.

Explosion of a Locomotive Boiler (Explosion d'Une Chaudière de Locomotive). P. Bardy. A description of a serious explosion of the boiler of a locomotive at the St. Lazare Station, at Paris. 1500 w. Génie Civil—July 9, 1904. No. 63918 D.

Exposition Plant.

The Steam Plant of the St. Louis Exposition. Remarks on the Exposition, with illustrated description of the power plant. 5000 w. Power—July, 1904. No. 63686 C.

Feed Water.

Foaming Waters and Scaling Waters for Locomotive Boilers. M. E. Wells. Considers boiler troubles due to the water used and the remedies. 2500 w. Eng News—July 21, 1904. No. 64036.

Governing.

The Governing of High-Speed Engines. J. H. Dales. Investigates the principles on which governing apparatus is constructed, discussing the several types of governor which are in general use. 2200 w. Engng Rev—July, 1904. Serial. 1st part. No. 64012 B.

Lubrication.

Lubrication of Steel Works and Blast Furnace Engines and Machinery. William M. Davis. Read before the Ohio Soc. of Mech., Elec. and Steam Engrs. Treats the subject from the engineer's point of view, considering efficient lubrication and cost. 2200 w. Engr, U S A—July 15, 1904. No. 63863 C.

Pumping Engines.

See Mech. Engineering, Hydraulics.

Safety Devices.

Water Columns and Low-Water Alarms. R. T. Strohm. Illustrates and describes various forms of these devices, and shows the advantages to be derived from the use of a good water alarm. 2700 w. Am Elect'n—July, 1904. No. 63680.

Steam.

A Study of Steam Generation (Etude sur la Production de la Vapeur). A. Lencauchez. An examination of the principles involved in steam generation, and a discussion of the extent to which they are realized in existing steam boilers. 1200 w. 3 plates. Mem Soc Ing Civ de France—March, 1904. No. 63939 G.

Steam Engines.

Engines of H. M. S. Prince of Wales. Illustrations, with brief description. 500 w. Engr, Lond—July 1, 1904. No. 63-762 A.

Portable Steam Engines of To-Day. J. C. R. Adams. The present article discussses some of the theoretical considerations which have played an important part in the development. Ills. 2700 w. Page's Mag.—July, 1904. Serial. 1st part. No. 64011 B.

Tod Rolling Mill Engines. Illustrates and describes modern engines built at Youngstown, Ohio. 3400 w. Ir Age—July 28, 1904. No. 64149.

Steam Plants.

The Choice of a Steam Plant, with Special Reference to American Electric Power Installation. George H. Barrus. Briefly considers steam turbines, the choosing of a reciprocating engine, the selection of boilers, &c. 3000 w. Cassier's Mag—July, 1904. No. 63872 B.

Steam Turbines.

The Curtis Steam Turbine. Frank C. Smallpiece. From a paper before the Can. Elec. Assn. Describes this type, claiming advantages over other forms and giving results of tests made. 3500 w. Can Engr—July, 1904. No. 63854.

The Nozzles of the DeLaval Steam Turbine (Zur Frage der Lavalschen Turbinendüsen). Karl Büchner. An examination of the manner in which the form of the nozzle affects the expansion of the steam, discussing the experiments of Mollier, Fliegner, Rosenhain and the author. Serial. Part I. 3500 w. Zeitschr d Ver Deutscher Ing—July 9, 1904. No. 63-910 D.

The Rateau Steam Turbine (La Turbine á Vapeur du Systeme Rateau). J. Rey. An exhaustive review of the design and applications of the Rateau turbine, with data and results of tests. 20000 w. 1 plate. Mem Soc Ing Civ de France—April, 1904. No. 63941 G.

The Steam Turbine and Its Applications (Die Dampfturbinen und ihre Anwendungen). W. Boveri. Discussing especially the Parsons turbine as made by Brown, Boveri & Co., of Baden, Switzerland. 8000 w. Stahl u Eisen—July 1, 1904. No. 63951 D.

The Steam Turbine—the General Theory, and That of Its Special Types. M. Blieden. Extract from a paper on the methods of compounding, types, governing, efficiencies, &c. 9000 w. Jour of So. African Assn of Engrs—April, 1904. No. 64143 E.

The Zoelly Steam Turbine (Die Dampfturbine System Zoelly). J. Weishaüpl. A detailed description of the improved steam turbine built by Escher, Wyss & Co., of Zürich, Switzerland. Two articles, 3500 w. Schweiz Bauzeitung—June 18, 25, 1904. No. 63966 each B.

Stokers.

Mechanical Stokers. W. Rogers. Briefly describes the principles of the different forms of mechanical stokers, giving illustrations and discussing details. 3200 w. Elec Engr, Lond—June 24, 1904. No. 63642 A.

The Mechanical and the Human Operator. Edwin Yawger. Abstract of a paper before the Boston Convention of the Nat. Elec. Lgt. Assn. Presents some of the general considerations that bear on the art of combustion of fuel in boiler furnaces. Discusses the points needed by stokers to insure economy and the shortcomings of the human element on both kinds of firing. 3000 w. Am Electn—July, 1904. No. 63677.

Superheating.

The Specific Heat of Superheated Steam. Robert H. Smith. A discussion of the investigations made by Prof. H. Lorenz for making exact measurement of the specific heat, and of his results. A graphic interpretation of the results is given and explained. 2500 w. Engr, Lond—July 8, 1904. No. 63895 A.

Water-Hammer.

Water-Hammer in Steam Pipes. Gives cases of entrapped water in piping which have caused accidents. Ills. 1500 w. Locomotive—July, 1904. No. 63721.

MISCELLANY.

Aeronautics.

A New Aerial Screw Propeller (Sur une Nouvelle Hélice Aérienne). H. Hervé and H. La Vaulx. Data and results of experiments with propellers, giving the elements of the type which showed the best results. 1200 w. Comptes Rendus—June 27, 1904. No. 63922 D.

The Barton Airships. Four views of this large airship, with information concerning its equipment. 500 w. Auto Jour—July 9, 1904. No. 63879 A.

The Equilibrating of Dirigeable Balloons (Sur l'Empennage des Carènes des Ballons Dirigeables). Ch. Renard. A discussion of the proper form of gas bag to insure the maximum degree of stability in a balloon. 1200 w. Comptes Rendus—June 20, 1904. No. 63919 D.

The New Nemethy Flying Machine and the Principle of Its Construction. Dr. Alfred Gradenwitz. States the rules followed, and gives an illustrated description. 1500 w. Sci Am—July 9, 1904. No. 63729.

The Stability of Dirigeable Balloons (Sur la Stabilisation de Route des Ballons Dirigeables). Henri Hervé. A discussion of the form of balloon and arrangement of propeller and guide vanes to secure maximum stability. 1000 w. Comptes Rendus—July 4, 1904. No. 63923 D.

Exhibition.

The Bradford Exhibition. Begins an account of this exhibition in England, being held to celebrate the opening of a fine building given as a memorial to Cartwright, the inventor of the power loom, and the originator of the wool-combing machine. Ills. 1800 w. Engr, Lond—June 24, 1904. Serial. 1st part. No. 63652 A.

Ferris Wheel.

Taking Down and Re-erecting the Ferris Wheel. Describes the interesting engineering work in handling a structure of great dimensions and weight, at a great height. Ills. 2300 w. Eng Rec—July 9, 1904. No. 63781.

MINING AND METALLURGY

COAL AND COKE.

Briquettes.

The Influence of the Strength of Coal Briquettes upon Their Steaming Value (Der Einfluss der Festigkeit von Steinkohlen briketts auf ihre Verdampungsfähigkeit). E. J. Constam. Data and results of tests, showing the steaming value of briquettes to be unaffected by their broken condition. 2000 w. Zeitschr d Ver Deutscher Ing—June 25, 1904. No. 63903 D.

China.

Notes on the Coal- and Iron-Fields of Southeastern Shansi, China. William H. Shockley. A record of observations made in the service of the Pekin Syndicate during the first months of 1898, among the coal- and iron-fields of Southeastern Shansi, one of the largest anthracite regions known. Ills. 10800 w. Trans. Am. Inst of Min Engrs—Oct., 1903. No. 64121 C.

Coal-Cutting.

Coal-Cutting by Machinery. G. L. Kerr. Illustrates and describes types of machines used in the mines of the United Kingdom, their working, &c. Also discusses the conditions suitable for coal-cutting machines, timbering, motive power, cost, advantages and disadvantages. 18000 w. Ir & Coal Trds Revs—June 24, 1904. No. 63656 A.

Coal Handling.

Modern Coal-Hoisting Apparatus. Frank C. Perkins. Illustrations with notes on examples of cranes, hoisting towers, engines and buckets. 1100 w. Sci Am Sup—July 30, 1904. No. 64156.

Colliery.

The Vesta No. 4 Colliery. Illustrated description of a mine in Western Pennsylvania, of interest because of its costly equipment. 2800 w. Eng & Min Jour—June 30, 1904. No. 63623.

Coal Storage.

See Marine and Naval Engineering.

Exhibiton.

The Colliery Exhibition. An account of the opening at Islington, with brief illustrated descriptions of the exhibits. 31-500 w. Col Guard—July 1, 1904. No. 63751 A.

The Colliery Exhibition. An illustrated general survey of the exhibits at the Royal Agricultural Hall, London, N. 19000 w. Ir & Coal Trds Rev—June 24, 1904. No. 63655 A.

Queensland.

Queensland Coal Mining Industry. Extracts from the report of the Inspector of Mines for the year 1903. Information concerning output, quality, mines, &c. Ills. 5500 w. Queens Gov Min Jour—May 14, 1904. No. 63601 B.

COPPER.

Arizona.

The Ore Deposits of Bisbee, Arizona. F. L. Ransome. Information in regard to these mines, which produce principally copper. 2200 w. Min & Sci Pr—July 16, 1904. Serial. 1st part. No. 64062.

Concentration.

Ore Dressing at Cananea. Dwight E. Woodbridge. Describes the new concentration mill of the Green Consolidated

Copper Company, the ores, and the methods used. Ills. 1200 w. Eng & Min Jour—June 30, 1904. No. 63624.

Extraction.

Wet Processes of Copper Extraction. Lionel C. Ball. Brief descriptions of the different wet processes likely to be suitable for Queensland ores. 8000 w. Queens Gov Min Jour—May 14, 1904. Serial. 1st part. No. 63602 B.

Mexico.

Copper Deposits in Sinaloa and Southern Sonora. Forbes Rickard. Notes and impressions during a recent visit to this mining region. 2500 w. Eng & Min Jour —July 21, 1904. No. 64029.

Mines.

The Planet Copper Mines. H. L. McCarn. A section of the Planet gulch and hill in Arizona, with description of the iron and copper deposits. 1500 w. Eng & Min Jour—July 7, 1904. No. 63700.

Ores.

Copper-Ore and Garnet in Association. William P. Blake. Shows the wide distribution of garnet as an associate of copper ore, discussing briefly the origin of these formations. 1500 w. Trans Am Inst of Min Engrs—Oct, 1903. No. 64119.

Veins.

Butte Copper Veins. Horace V. Winchell. Illustrates graphically the main points of structure, mineralization and associated rocks, stating the facts shown. 1000 w. Eng & Min Jour—July 7, 1904. No. 63697.

GOLD AND SILVER.

Assay Furnace.

A Portable Assay Furnace. J. J. Gillis. Gives results of a trial extending over several months of fairly frequent work, and under all sorts of conditions, in which kerosene was used in a modified gasoline furnace. 1800 w. Aust Min Stand—May 19, 1904. No. 63636 B.

Australia.

Black Range Goldfield (W. A.) A report of this field, which promises to become a large producer in the near future. 2500 w. Aust Min Stand—June 2, 1904. No. 64069 B.

Broken Hill. Donald Clark. An illustrated review of this noted mining region, yielding gold, silver and lead. 1700 w. Aust Min Stand—June 9, 1904. Serial. 1st part. No. 64074 B.

The Indicators of Daylesford. Describes this goldfield, reviewing briefly the history of its workings. Ills. 1600 w. Aust Min Stand—June 2, 1904. No. 64-072 B.

Bendigo.

The Future of Bendigo (V.). W. H. Cundy. Begins an account of this important gold-producing center in Victoria. 1400 w. Aust Min Stand—May 26, 1904. Serial. 1st part. No. 63638 B.

Cyanide.

The Care of Cyanide Solutions. W. H. Davis. Discusses the application of solution schedules and the precautions to be exercised in their handling. 2000 w. Eng & Min Jour—July 21, 1904. No. 64030.

The Refining of the Precipitates Obtained by Means of Zinc in the Cyanide Process of Gold and Silver Extraction. G. Howell Clevenger. Explains the nature of precipitates, giving a report of experimental work upon alloys; reviews the present methods of refining, concluding that smelting with lead, after the removal of the zinc, is best. 8500 w. Trans Am Inst of Min Engrs—Oct, 1903. No. 64112 C.

Egypt.

Gold Mining in Egypt. Charles F. Alford. Abstract from Trans. of the Inst. of Min. & Met. Gives some facts in regard to ancient mines which have been rediscovered and are again being worked. 1200 w. Ills. Mines & Min—July, 1904. No. 63827 C.

Free Gold.

Free Gold Below the Zone of Surface Oxidation. Arthur Lakes. Cites instances where free gold is found, and inferences drawn from the facts. 600 w. Min Rept—July 14, 1904. No. 63861.

Milling.

Gold Milling. Algernon Del Mar. Notes giving information in regard to mill work. 2800 w. Min & Sci Pr—July 16, 1904. Serial. 1st part. No. 64061.

Notes on Mill Construction, Milling and Amalgamation. Discussion of I. Roskelley's paper on this subject. 16500 w. Jour of Chem, Met & Min Soc of S. Africa—May, 1904. No. 63883 E.

Nome.

Possibilities of Quartz Mining in Nome District, Alaska. F. Lundstrom. Describes the characteristics of the district, and considers that quartz mining ought to be successful. 900 w. Min & Sci Pr—July 9, 1904. No. 63862.

Placers.

Blasting Tight Placers Before Dredging. Oliver B. Finn. An illustrated detailed account of the way a Keystone driller was used in California to loosen, by blasting, a very tight gravel deposit, preparatory to dredging. 900 w. Eng & Min Jour—July 7, 1904. No. 63698.

Sampling.

The Sampling of Mill Dumps or Tailing Ponds. A. W. Warwick. Gives the method adopted by the writer, illustrating by example. 1500 w. Min Rept—July 21, 1904. No. 64058.

Separation.

Separation of Gold from Copper. F. R. Carpenter. An account of investigations made to devise some dry method whereby the matte might be refined at the plant where it is made. 1800 w. Aust Min Stand—May 12, 1904. No. 63635 B.

Siberia.

The Gold Mining Districts of Central Siberia. Lewis Blanchard Brown. Describes the South-central part of Siberia, with special reference to its geology and mineral deposits. Map. 10300 w. Trans Am Inst of Min Engrs—Oct, 1903. No. 64113 C.

Smelting.

The Custom Smelting Industry in Mexico. Jas. W. Malcolmson. A statement of the present situation and of the changes being made to relieve it. Treatment rates are discussed and the advantages which copper matte has over lead as a vehicle for the concentration of gold and silver contained in silicious ores. 1800 w. Eng & Min Jour—July 7, 1904. No. 63699.

Water.

The Modern Theories of the Flow of Water and Their Application in Gold Mining. Prof. H. S. Hele-Shaw. A study of the ways in which water moves. Ills. 5500 w. Jour of Chem, Met, & Min Soc of S. Africa—May, 1904. No. 63884 E.

IRON AND STEEL.

Cast Iron.

See Mechanical Engineering, Materials.

Cementation.

Recent Experiments upon the Cementation of Carbon and Special Steels (Nouvelles Recherches sur la Cementation des Aciers au Carbone et des Aciers Speciaux). Léon Guillet. Determinations of the rapidity of penetration of the carbon for different materials of cementation. 1000 w. Comptes Rendus—June 20, 1904. No. 63920 D.

The Cementation of Special and Carbon Steels (La Cémentation des Aciers au Carbone et des Aciers Speciaux). Léon Guillet. Applying the methods of metallography to the study of cementation of steel showing the action of different materials. 8000 w. 1 plate. Mem Soc Ing Civ de France—Feb., 1904. No. 63934 G.

Electric Smelting.

The Electro Metallurgy of Iron and Steel. Emile Guarini. Reviews the progress made thus far in melting metals by electricity, 1200 w. Sci Am Sup—July 30, 1904. Serial. 1st part. No. 64158.

The Electric Smelting of Iron and Iron Alloys (Die Elektrothermische Erzengung von Eisen und Eisenlegierungen). B. Neumann. Illustrating and describing various forms of electric furnaces for smelting iron and refining steel. Serial. Part I. 3500 w. Stahl u Eisen—June 15, 1904. No. 63946 D.

The Manufacture of Iron by Electrochemical Processes. Adolphe Minet. A complete and fully illustrated review of the new methods of electric smelting, and their results. 5000 w. Engineering Magazine—August 6, 1904. No. 63977 B.

Magnetic Ores.

Origin of the Magnetic Iron-Ores of Iron County, Utah. E. P. Jennings. Describes these deposits, and gives the writer's conception of their origin. Ills. 1200 w. Trans Am Inst of Min Engrs—Feb, 1904. No. 64126.

Mexico.

A Rolling Mill at Monterey, Mexico (Walzwerksanlage in Monterey, Mexiko). Oskar Goldstein. With plan of the works and views of the various departments. Rails and structural shapes are rolled. 2000 w. 1 plate. Stahl u Eisen—June 15, 1904. No. 63947 D.

Open-Hearth.

Notes on Processes for Producing Open-Hearth Steel. R. M. Dallen. An illustrated article written chiefly for the purpose of making a comparison between the basic-Bessemer and the open-hearth processes. 3600 w. Ir & Coal Trds Rev —June 24, 1904. No. 63657 A.

Pig Iron.

See Mechanical Engineering, Material.

Scandinavia.

Iron Ore Mining in Scandinavia. W. Fischer Wilkinson. Read before the Inst. of Min. & Met. Information concerning the deposits, and the importance to this industry of the recently constructed railroad which gives access to the Atlantic port of Narvik. Ills. 4300 w. Ir & Coal Trds Rev—July 1, 1904. No. 63771 A.

Steel.

The Synthesis of Bessemer Steel. F. J. R. Carulla. A discussion of the value of the Bessemer process, urging its restoration to the confidence it deserves. 4400 w. Eng News—July 7, 1904. No. 63704.

MINING.

Alaska.

The Investigation of Alaska's Mineral Wealth. Alfred H. Brooks. An outline of what has been and is being accomplished toward furthering the knowledge of Alaska's mineral wealth, giving the operations of the U. S. Geol. Survey in the Territory. Map. 6000 w. Trans Am Inst of Min Engrs—Sept, 1904. No. 64115.

Brakes.

Hoisting-Engine Brakes. J. S. Lane. Illustrates and describes the different kinds, the methods of operating them and the principles governing their construction and action. 2700 w. Mines & Min—July, 1904. No. 63812 C.

Concentration.

Concentration of Ores in Rossland District. Description of the Elmore Oil Process. Ills. 3200 w. B C Min Rec—July, 1904. No. 63709 B.

Drills.

Electrically-Driven Impact Drills (Die Stossbohrmaschinen mit Elektrischem Antrieb). Paul Sorgo. An illustrated account of the electric rock drills made by the Austrian Siemens-Schuckert Works. 2500 w. 1 plate. Oesterr Zeitschr f Berg u Huttenwesen—June 18, 1904. No. 63942 D.

Rock Drills. Ewart C. Amos. Refers to early machines, comparing them with the latest types, and considers in detail percussion drills and diamond prospecting drills. Ills. 5800 w. Engng Rev—July, 1904. No. 64013 B.

The Box Electric Rock-Drill. Frank E. Shepard. Illustrated description of drill invented by W. A. Box, with details of construction and operation.* 4300 w. Trans Am Inst of Min Engrs—Feb., 1903. No. 64114.

Electric Power.

Electrically-Driven Mining Fan. Illustrated description of a fan at Pelton Colliery, in Durham. 600 w. Engr, Lond—June 24, 1904. No. 63654 A.

Electrical Mining Machinery. Illustrates and describes various types of machines now in use in British mines. Also their use at Acton Hall Colliery. 15500 w. Engr, Lond—June 24, 1904. Supplement. No. 63653 A.

Electrical Apparatus for Coal Mining. A reply to the discussion by W. L. Saunders of the paper of W. B. Clark, presented at the Albany meeting, Feb., 1903. 3600 w. Trans Am Inst of Min Engrs—May 18, 1904. No. 64116.

Explosives.

Annual Report of His Majesty's Inspectors of Explosives, 1903. A review of this report, investigating accidents and giving information of the manufacture, importation, &c. 4500 w. Col Guard—July 15, 1904. No. 64089 A.

The Manufacture of Some High Explosives. R. S. King. Deals with the processes of manufacture of nitroglycerine, gun cotton, dynamite, gelatine and contractors' powder. Ills. 1700 w. Engrs' Soc, Univ of Minn—Year Book, 1904. No. 64105 D.

Foundations.

Hoisting Engine Foundations. R. V. Norris. On the importance of suitable construction even for temporary purposes, discussing methods of building and comparative costs. 2000 w. Mines & Min—July, 1904. No. 63813 C.

Head-Frames.

Head-Frames and Tipples. W. R. Crane. Illustrates and describes types of head frames to be seen in the Mississippi Valley. 2500 w. Eng & Min Jour—July 14, 1904. No. 63801.

Hoisting.

An Investigation Regarding the Effect of Kinetic Shocks on Winding Ropes in Vertical Shafts. J. A. Vaughan. Gives an inquiry as to the case of a rope which is suddenly stopped while lowering a load with uniform velocity, studying the effects. Diagrams. 10600 w. Jour of Pro of So African Assn of Engrs—March, 1904. No. 63716 E.

Balanced and Unbalanced Hoists. E. T. Sederholm. A comparison of the different types and relative economies of various methods. Ills. 6500 w. Mines & Min—July, 1901. No. 63811 C.

Care and Handling of Hoisting Engines. J. H. Pennington. Suggestions for keeping it in proper order. 1600 w. Mines & Min—July, 1904. No. 63818 C.

Choice of a Hoisting Engine from the Standpoint of the Purchaser. How to determine the size of the engine required. 800 w. Mines & Min—July, 1904. No. 63824 C.

Coal Winding Machinery. Horace D. B. How. Abstract of essay awarded the Lewis first prize, 1903. Pro. South Wales Inst. of Engrs. Describes two novel forms of electrical winding gears, comparing with a steam-winding engine from a mechanical and financial point of view. Ills. 5000 w. Ir & Coal Trds Rev—July 8, 1904. No. 63899 A.

Compounding in Hoisting Engines. A comparison of the relative economy of hoisting with compound, condensing and simple engines. 2800 w. Mines & Min—July, 1904. No. 63815 C.

Compressed Air in Hoisting. J. S. Lane. The kinds of hoists and methods of applying for different purposes, reheating, adapting steam apparatus for the use of air, &c. Ills. 4000 w. Mines & Min—July, 1904. No. 63825 C.

Cylindrical *vs.* Conical Drums. F. Moeller. Considers the advantages and disadvantages of the different types, giving details of methods of construction of drums for various purposes. Ills. 1800 w. Mines & Min—July, 1904. No. 63819 C.

Drums *vs.* Reels for Hoisting. F. F. Coleman. Discusses different types of drums and some points in regard to reel hoists and flat ropes. 2000 w. Mines & Min—July, 1904. No. 63826 C.

Electric Hoists. On the advantages of the electric type, the development, and their use for deep hoisting in America, Germany and South Africa. 2200 w. Mines & Min—July, 1904. No. 63820 C.

Gas or Liquid-Fuel Hoisting Engines. E. W. Roberts. Discusses their economy as compared with steam engines, and some of the materials which may be used as fuels. Ills. 2500 w. Mines & Min—July, 1904. No. 63829 C.

Hoisting Engine Calculations. Gives methods of calculating sizes and power of engines required to do a given work. 2400 w. Mines & Min—July, 1904. No. 63828 C.

Hoisting Engine Specifications. F. W. Gerecke. Gives sample specifications for a pair of heavy hoisting engines for use at a coal mine. 2800 w. Mines & Min—July, 1904. No. 63814 C.

Some Indicator Cards from Winding Engines. W. A. Macleod. Illustrations of different degrees of economy obtained by different methods of running. 2400 w. Mines & Min—July, 1904. No. 63821 C.

Tail- or Balance-Rope Hoists in Shafts in the Anthracite Regions of Pennsylvania. Arthur H. Storrs. A description of the Poore System. 1400 w. Mines & Min—July, 1904. No. 63822 C.

The Practical Installation of Electrical Hoisting Machinery (Die Zweck-mässige Ausgestaltung Elektrisch Betriebener Hauptschacht fördermaschinen). Karl Ilgner. A comparison of electrical with mechanical winding, showing the advantages of electric motors. Two articles. 7000 w. Zeitschr d Oesterr Ing u Arch Ver—June 17, 24, 1904. No. 63925 each D.

The Siemens-Ilgner System for Electric Mine Hoists. Illustrated description of a hoist now in use at the Zollern II. colliery, at Merklinde, Germany, using electric power. 1500 w. Eng & Min Jour—June 30, 1904. No. 63625.

The Winding Engine for the Boston and Montana Consolidated Copper and Silver Mining Co. (Fördermaschine für die Boston and Montana Consolidated Copper and Silver Mining Co.). Fr. Frölich. Detailed description of the Nordberg engines for use with flat ropes. 3000 w. Zeitschr d Ver Deutscher Ing—June 25, 1904. No. 63902 D.

Types of Hoisting Engines and the Adaptability of Each. S. T. Nicholson. Descriptions, with drawings, showing some of the standard methods of construction. 2000 w. Mines & Min—July, 1904. No. 63817 C.

India.

Mineral Resources of British India. Sarat C. Rudra. Notes briefly the mineral locations, their quality, quantity, and prospects, the condition of labor, the means of communication, facility of obtaining power, &c. Gold, lead, copper, iron, antimony and graphite are found, and also diamonds. 12000 w. Trans Am Inst of Min Engrs—Oct, 1903. No. 64120 C.

Mine Gases.

Sulphuretted-Hydrogen Gas in Quartz Mines. R. M. Aitken. Discusses accidents due to mine gases, especially one on March 29, in the Energetic Mine, Rufton district. 1800 w. N Z Mines Rec—May 16, 1904. No. 63611 B.

Misplacement.

Misplacements of Shafts and Adits. Stanley Hunter. Gives examples in the mines of Victoria, where money has been needlessly expended through such misplacements. Ills. 1800 w. Aust Min Stand—May 26, 1904. No. 63639 B.

Ontario.

Undeveloped Mineral Resources of Ontario. Willet G. Miller. Read before the Can. Min. Inst. An outline of the field awaiting development, considering metals and their ores, minerals used for grinding and polishing, refractory materials, pigments, gems, minerals used in chemical manufactures, in agriculture. for brick, pottery and glass, fuels, cement, stone, &c. 6400 w. Can Min Rev—June 30, 1904. No. 63727 B.

Ore Shoots.

Ore Shoots and Veins That Do Not Come to the Surface. A. Lakes. Illustrates and describes unusual deposits. 1200 w. Min Rept—July 21, 1904. No. 64057.

Quartz Mining.

The Young Quartz Miner. Matt. W. Alderson. The present article deals with the tools needed, and how to shape, sharpen, harden and temper them. 1600 w. Min & Sci Pr—June 25, 1904. Serial. 1st part. No. 63670.

Safety Device.

Improved Safety Device for Cages and Skips. J. J. Jordan. Outline description, with illustrations, of a device aiming to provide a stronger means of securing the cage in case of breakage of the hoisting rope. 450 w. Min Rept—July 14, 1904. No. 63860.

Sampling.

A Comparison Between Two Methods of Mine Sampling. A. W. Warwick. Briefly describes the two methods and compares the results. 800 w. Min Rept—July 7, 1904. No. 63775.

Shafts.

Deep Hoisting in South Africa. J. S. Lane. Explains the conditions which necessitate deep shafts, describing some of the devices recommended and plants which have been installed. Ills. 3600 w. Mines & Min—July, 1904. No. 63816 C.

Deep Hoisting in the Lake Superior District. O. P. Hood. Describes some of the engines used to hoist from a depth of over 4,900 feet. Ills. 4200 w. Mines & Min—July, 1901. No. 63823 C.

South Africa.

The Equipment of the Lancaster West Mine. Edgar Smart. The present article gives an illustrated description of the chief points of interest noted during a visit to this South African mine. 2700 w. Page's Mag—July, 1904. Serial. 1st part. No. 64010 B.

South Dakota.

Review of South Dakota Mining Conditions. Jesse Simmons. Information concerning the milling plants, Homestake belt, contact deposits, cyanidation, and a producing tin mine. Ills. 1800 w. Min Rept—July 21, 1904. No. 64059.

Timbering.

Steel to Replace Timbering. R. V. Norris. Describes types of steel supports in use in the anthracite region, giving table of comparison with the strength of timber, of value in proportioning such supports. Ills. 900 w. Eng & Min Jour—July 14, 1904. No. 63800.

Valuation.

Appraisal of the Value of Mineral-Lands, with Especial Reference to Coal-Lands. H. M. Chance. Discusses principally the methods used in the appraisal of the value of coal-lands. 5000 w. Trans Am Inst of Min Engrs—Sept, 1904. No. 64122.

Ventilation.

Air Locks in the Deutscher Kaiser Mine at Hamborn (Luftschleusen-Anlage auf dem Wetterschacht IV. der Gewerkschaft Deutscher Kaiser in Hamborn). H. Grahn. A description of special air locks in connection with the ventilation of a mine during deepening. 1500 w. 1 plate. Glückauf—June 18, 1904. No. 63944 D.

The Ventilating Plant of the Nothberg Mine in the Eschweiler District (Die Ventilatoranlage auf Grube Nothberg des Eschweiler Bergwerksvereins). F. Collischonn. With plan of the workings, and illustrations of the motor plant and electrically driven fans. 2000 w. Glückauf—July 9, 1904. No. 63945 D.

Wire Cutting.

Cutting Rocks with the Helicoidal Wire. From the *Bul. de la Soc. d'Encour. Pour l'Ind. Nat.* Briefly reviews the history of this method of sawing stone, describing the plant and the success. Ills. 1500 w. Quarry—July, 1904. No. 63770 A.

MISCELLANY.

Assay.

The Commercial Wet Lead-Assay. H. A. Guess. Gives results of extensive laboratory experiments, during which a new method was developed, and tested with all kinds of pure and impure lead-ores and products. 4500 w. Trans Am Inst of Min Engrs—Sept., 1904. No. 64117.

Arsenic.

The Arsenic Mines at Brinton, Virginia. John L. Cowan. An illustrated account of these mines and their development. 1100 w. Eng & Min Jour—July 21, 1904. No. 64031.

Discoloration.

Superficial Blackening and Discoloration of Rocks, Especially in Desert Regions. William P. Blake. Discusses the causes. 1600 w. Trans Am Inst of Min Engrs—Sept., 1904. No. 64124.

East Indies.

The Mineral Wealth of the Dutch East Indies (Les Richesses Minérales des Indes Orientales Néerlandaises). J. G. Bousquet. A very complete review of the mineral wealth of Java, Sumatra, Borneo, and the Dutch East Indies generally, including the workings for coal, petroleum, tin, gold, silver, and diamonds. 15000 w. 1 plate. Mem Soc Ing Civ de France—April, 1904. No. 63940 G.

Fossils.

The Carboniferous Epoch and Its Flora. John Pringle. Read before the N. Wales Branch of the Nat. Assn. of Coal Mgrs. A sketch of the carboniferous formation of Great Britain, and its flora. 5500 w. Ir & Coal Trds Rev—July 1, 1904. No. 63772 A.

Idaho.

The Bomb-Throwing Volcanoes of Idaho. Arthur Lakes. Description of this interesting phenomena, with illustrations. 800 w. Min Rept—July 7, 1904. No. 63774.

Kerosene.

Kerosene Shale in Australia. John Plummer. Information concerning these deposits, the products derivable, &c. Ills. 2800 w. Eng & Min Jour—July 14, 1904. No. 63802.

Mining Engineers.

The Making of Mining Engineers. T. H. Palmer. Abstract of a paper read before the Sydney Univ. Engng. Soc. Discusses the qualifications and training needed. 5000 w. Aust Min Stand—June 9 & 16, 1904. Serial. 2 parts. No. 64073. each B.

Mining Law.

The Law of the Apex. Max Boehmer. Presents a proposition to simplify the apex law. 1300 w. Eng & Min Jour—July 14, 1904. No. 63799.

Molybdenite.

Molybdenite, Its Determination, Detection and Uses. Dr. J. Ohly. Information concerning this rare metal, and the means of detecting it, its uses, &c. 1700 w. Min Rept—July 7, 1904. No. 63776.

Platinum.

Some Notes on Platinum and Its Deterioration. William Campbell. On its crystalline structure, its occlusion of and permeation of gases, its behavior at high temperatures, &c. Ills. 2800 w. Elec-Chem Ind—July, 1904. No. 63730 C.

Poisonous Gases.

Arseniuretted Hydrogen in Hydrogen Sulphide. Dr. J. Ohly. Shows that the purification of hydrogen sulphide is attended with serious difficulties. 1400 w. Min Rept—July 7, 1904. No. 63773.

Tasmania.

North-East Dundas (T.) Tin. Describes the deposits of this district and the work done in developing. 1300 w. Aust Min Stand—June 2, 1904. No. 64071 B.

Tin.

Queensland Tin Supply. Information concerning the output, which shows a marked increase. 1200 w. Aust Min Stand—June 2, 1904. No. 64070 B.

The Herberton Tin Field. Walter E. Cameron. Location and geology of the deposits, character of the mining, &c. Map. 6500 w. Queens Gov Min Jour—May 14, 1904. Serial. 1st part. No. 63603 B.

Tin Scrap.

See Electrical Engineering, Electrochemistry.

Zinc.

The Smelting of Zinc Ores to Regain Spelter and Sulphuric Acid. A. J. Diescher. Information concerning zinc ores with a detailed description of the process of smelting. Discussion. Ills. 12000 w. Pro Engrs' Soc of W Penn—March, 1904. No. 63866 D.

RAILWAY ENGINEERING

CONDUCTING TRANSPORTATION.

High Speed.

High Speeds on Main-Line Railways (Schnellbetrieb auf Hauptbahnen). H. von Borries. A discussion of the results of the Marienfelde-Zossen trials and description of the steam locomotives to be tried on the same line. 5000 w. 1 plate. Zeitschr d Ver Deutscher Ing—June 25, 1904. No. 63901 D.

Local Traffic.

The Development and Handling of Local Railway Traffic. Discusses the question of motor car service on steam railways. 3500 w. Eng News—July 28, 1904. No. 64153.

Long Run.

London to Plymouth Without a Stop. A. G. Robins. Notes on the train service of the Great Western Railway, with reference also to other lines and to the progress recently made. 2500 w. Engng—July 15, 1904. No. 64093 A.

The Longest Non-Stopping Railway Run in the World. Charles Rous-Marten. An interesting account of two regular daily runs on the Great Western railway of 245¾ miles without halt—from Paddington to Plymouth and return. 2200 w. Engr, Lond—July 8, 1904. No. 63897 A.

Narrow Gauge.

The Industrial Importance of the Narrow Gauge Railway (Die Schmalspurbahnen und ihre Volkswirtschaftliche Bedeutung). Josef Ritt. v. Wenusch. A review of the history of narrow gauge railways, advocating the construction of double-track narrow-gauge roads to benefit the agricultural districts of Austria. Three articles. 10000 w. Zeitschr d Oesterr Ing u Arch Ver—June 10, 17, 24, 1904. No. 63924 each D.

Tickets.

A Machine for Printing and Recording Tickets (Machine à Fabriquer et à Comptabiliser les Billets). MM. Leo & Dugit-Chesal. Illustrated account of an automatic railway ticket machine under trial by the Northern Railway of France. 7000 w. Rev Gen des Chem de Fer—June, 1904. No. 63930 G.

Train Service.

British and French Summer Train Services in 1904. Charles Rous-Marten. The present article is a review of the service on British railways, calling attention to the progress made and novelties introduced. 2500 w. Engr, Lond—July 15, 1904. Serial. 1st part. No. 64097 A.

MOTIVE POWER AND EQUIPMENT.

Axles.

Steel Axles. J. L. Replogle. Considers the method of manufacture, discusses the best specification, suggesting changes in the M. C. B. specifications and the causes of broken axles. General discussion. 6000 w. Pro W Ry Club—May 17, 1904. No. 63599 C.

Car Heating.

Heating by Steam upon French Railways. Brief descriptions of the four systems now in service. Ills. 2500 w. Ry Age—July 8, 1904. No. 63788.

Car-Wheels.

Standard Specifications for Cast-Iron Car-Wheels. Charles B. Dudley. Discussing the specifications submitted by the sub-committee of the Am. Soc. for Test. Materials. 3300 w. Trans Am Inst of Min Engrs—Feb., 1904. No. 64125.

Cars.

Second Class Railway Cars with Bogie Trucks (Les Voitures de Seconde Classe à Bogies). Robert Dubois. Detailed description of improved passenger cars of the Western Railway of France, with steel girder sills. 5000 w. Rev Gen des Chem de Fer—June, 1904. No. 63931 G.

Headlights.

The Electric Headlight as a Safety Appliance. Considers briefly their advantages and deficiencies. General discussion. 5400 w. Pro W Ry Club—May 17, 1904. No. 63600 C.

Locomotive Practice.

American Locomotive Practice. Percy John Cowan. Paper and discussion before the Inst. of Civ. Engrs. in London. Gives an account of the latest ideas adopted by American locomotive engineers as observed by an expert. Also a summary of the views drawn out by this paper. Ills. 14800 w. Bul Int Ry Cong—June, 1904. No. 63768 E.

Locomotives.

Belgian State Railways Locomotive with Six Coupled Wheels and Leading Bogie. Illustrations, principal dimensions, and detailed description of one of the most powerful locomotives recently constructed in Europe. 1500 w. Bul Int Ry Cong—June, 1904. No. 63769 E.

Early Engines in Michigan. Clinton B. Conger. Describes an interesting engine built about 1850. 1000 w. Loc Engng—July, 1904. No. 63722 C.

Express Locomotives and Their Work. Charles S. Lake. Remarks on the wisdom of keeping careful records of the performance of locomotives of various design, with report of particulars gained during experimental trips on the Great Central Railway on engines designed by J. G. Robinson. Diagrams. 3000 w. Transport—July 8, 1904. No. 64025 B.

Locomotives for the Central South African Railroads. Brief illustrated description. 350 w. R R Gaz—July 8, 1904. No. 63706.

Locomotives for the Central South African Railways. H. W. Hanbury. Illustrations, with detailed description of a passenger, and also a goods locomotive, which are believed to be the heaviest and largest of their class ever built for the 3 ft. 6 in. gauge. 2000 w. Engng—July 1, 1904. No. 63757 A.

New York Central Express Compound Locomotive. Illustrated description of the balanced compound locomotive at the head of the Empire State Express, on exhibition at St. Louis. 700 w. Sci Am—July 30, 1904. No. 64154.

Tank Locomotive with Seven Axles for Mountain Railways (Locomotive Tender à Sept Essieux pour Chemins de Fer de Montagne). Description of powerful mountain locomotive by Henschel, of Cassel. 1500 w. 1 plate. Génie Civil—July 2, 1904. No. 63916 D.

The Mallet Duplex Compound Locomotive; Baltimore & Ohio Ry. Illustrated detailed description of this remarkable locomotive of 334,500 lbs. weight, carried on 12 wheels. 1700 w. Eng News—June 30, 1904. No. 63586.

The New Four-Cylinder Compound Locomotives of the Orleans Railway (Les Nouvelles Locomotives Compound de la Compagnie Orleans). P. Conte. Illustrated description of heavy express and freight engines of the de Glehn type. 6000 w. 5 plates. Rev Gen des Chem de Fer—July, 1904. No. 63932 G.

Oil Burners.

A New Arrangement of Fuel Oil Burners for Locomotives. Brief illustrated description of a new method brought out by the Southern Pacific Ry. 500 w. Am Engr & R R Jour—July, 1904. No. 63-726 C.

Oil Cup.

Automatic Air-Cylinder Oil Cup. Illustrated description of a device recently perfected by the Westinghouse Air Brake Co. 700 w. Loc Engng—July, 1904. No. 63724 C.

Resistances.

Resistance to Locomotive Traction at High Speeds. Discusses the methods of finding the resistance to the motion of a train in the experimental investigations made. 2000 w. Engng—July 8, 1904. No. 63894 A.

Safety Appliances.

Safety Appliances and Their Maintenance. George Hannauer. Read before the meeting of Cent. Assn. of R. R. Officers. Suggestions for the economical maintenance of power brakes, automatic couplers, &c. 3000 w. Pro St Louis Ry Club—June 10, 1904. No. 63628.

Steaming.

Locomotive Steaming Capacity. L. L. Bentley. Describes method of finding the steaming capacity, giving the results of a study of compound engines. 1200 w. Am Engr & R R Jour—July, 1904. No. 63725 C.

Vibration.

The Vibration of Railway Vehicles. Gives an account of a new method, invented by M. Sabouret, by which a full report can be drawn of the state of the line and of the technical conditions observed when it was laid down. Ills. 3300 w. Engr, Lond—July 15, 1904. No. 64101 A.

NEW PROJECTS.

China.

The Construction of the Lu Pao Section of the Lu-Han Railway. From a paper by T. J. Bourne presented to the Inst. of Civ. Engrs. Describes the construction of about 90 miles of this line. 2200 w. Eng Rec—July 23, 1904. No. 64049.

Isthmus Route.

The Tehuantepec Route. E. L. Corthell. An account of the fulfillment of the project for a traffic route across this isthmus, the difficulties overcome, the advantages and value of this route. Ills. 5000 w. R R Gaz—July 15, 1904. No. 63798.

Light Railway.

The Leek and Manifold Valley Light Railway. Illustrated detailed description of this recently opened road which has novel features of interest. 3000 w. Tram & Ry Wld—July 14, 1904. No. 64137 B.

Tunnels.

A Channel Railway. Henry Haguet. Discusses the prospect of a tunnel railway connecting France and England. 2300 w. Transport—July 8, 1904. No. 64024 B.

PERMANENT WAY AND BUILDINGS

Air Line.

The Atlanta & Birmingham Air Line. Illustrations, line drawings, and interesting data in regard to this road. 1500 w. R R Gaz—July 1, 1904. No. 63627.

Construction.

Impressions of a Resident Engineer on Railroad Construction. Friend P. Williams. Describes the location and construction of eight miles of modern railroad, reviewing the engineering side of the work and discussing points of special interest. 3000 w. Ills. Trans Assn of Civ Engrs of Cornell Univ—1904. No. 63606 F.

Culvert.

An Eighteen-foot Culvert, Bangor & Aroostook Railroad. Moses Burpee. An illustrated description, explaining the reason for making the span large, and also describing the construction. 800 w. Eng Rec—July 23, 1904. No. 64051.

Improvements.

The Atlantic Avenue Improvement of the Long Island Railroad in Brooklyn, N. Y. James B. French. An illustrated detailed description of the character and details of this work; it includes subway construction, steel viaducts, open cut, &c. 4500 w. Trans Assn of Civ Engrs of Cornell Univ—1904. No. 63604 F.

The Bridgeport Improvements of the New York, New Haven & Hartford Railroad. A statement of the conditions at this point, and an illustrated detailed description of difficult work in eliminating grade crossings and four-tracking this road without interfering with traffic. 2200 w. Eng Rec—July 23, 1904. Serial. 1st part. No. 64050.

Rails.

Bending Moments in Rails. Dr. P. H. Dudley. Read before the Am. Soc. of Test. Materials. Considers some of the relations of the problems of the rail section as a girder in carrying and distributing the load of passing locomotives to the foundation or sub-grade, as indicated by the bending moments. 2300 w. Ry & Engng Rev—July 2, 1904. No. 63719.

Stremmatograph Tests of Unit Fiber Strains and Their Distribution in the Base of Rails under Moving Locomotives, Cars and Trains. P. H. Dudley. Read before the Am. Sec. of the Internat. Soc. for Test. Materials, with revision and additions. Explains the functions of the stremmatograph and gives a record of the tests. 6800 w. Ills. Bul Int Ry Cong—June, 1904. No. 63767 E.

The Rail Section on Flexible Supports Under Rolling Loads a "Constrained Beam." P. H. Dudley. Reviews the researches of Mr. A. Flamache on the bending of rails, and gives other important data obtained by instrumental observations of precision of a different character, for the purpose of acquiring information of the strains in rails under moving loads. 4600 w. Bul Int Ry Cong—June, 1904. No. 63766 E.

Signalling.

Electric Signalling on Railways. Illustrates and describes the apparatus devised by Mr. Jan Voet, for repeating all signals on the engine. 1800 w. Elec Rev, Lond —July 1, 1904. No. 63747 A.

The Electric Signal System of the Central Railway Station at Antwerp (Appareils pour la Manœuvre Electrique des Aiguillages et des Signaux de la Gare Centrale d'Anvers). L. Weissenbruch. A general description of the Siemens electric switch and signal system at Antwerp. 7500 w. Rev Gen des Chem de Fer—July, 1904. No. 63933 G.

The Electro-Pneumatic Signal System of the Est Station in Paris (Manœuvre Electropneumatique des Signaux à la Gare de Paris-Est). E. Wagner. An account of the installation of the Westinghouse signal system in the terminal of the Eastern Railway of France at Paris. 1800 w. Génie Civil—July 9, 1904. No. 63917 D.

What Are the Merits of the Block System on Railroads Operating in Iowa. P. G. Campbell. Considers the details of manual blocking and the benefits. General discussion. 3500 w. Pro Iowa Ry Club—June 13, 1904. No. 63616.

Stock Yards.

Railway Stock Yards and Their Relation to the Train Department, Freight Department and Maintenance of Way Department. Also general discussion. 3000 w. Pro Iowa Ry Club—June 13, 1904. No. 63615.

Superstructure.

Recent Studies in the Superstructure of Railways (Neue Beobachtungen, Messungen, und Versuche am Eisenbahn-Oberbau). Dr. Haarmann. An address before the Berlin Railway Society discussing the changes necessary in permanent way to meet the modern demands. 7000 w. Glasers Annalen—June 15, 1904. No. 63952 D.

Tracks.

German Track and Signal Exhibit at the World's Fair. An illustrated description of the exhibit, explaining its working. 1800 w. Ry & Engng Rev—July 23, 1904. No. 64060.

Premium Track Inspection. Gives results of the annual inspection of track on one English and two American railroads, all of which have adopted the premium system of rewarding good work in that department. 1800 w. R R Gaz—July 22, 1904. No. 64033.

Trestles.

High Timber Trestles on the North Alabama Railroad. Illustrates and describes important trestle work from 60 to 80 feet high from foundation to rail. One is 116 feet in maximum height and is 684 feet long. 500 w. Eng Rec—July 23, 1904. No. 64053.

The Paoli Trestle on the Monon. A. E. Kemmer. Illustrates and describes a new steel trestle on the C. I. & L. Railroad, 870 ft. long and 87 ft. high. Includes about 4,300 cu. yds. of masonry. 500 w. R R Gaz—July 15, 1904. No. 63796.

Tunnels.

See Civil Engineering, Construction.

TRAFFIC.

Tonnage.

The Most Economic Tonnage Rating for a Locomotive in Freight Service. Papers by V. F. Finch, and by Harry Bentley, discussed together. 3000 w. Pro Iowa Ry Club—June 13, 1904. No. 63617.

STREET AND ELECTRIC RAILWAYS

Alternating Currents.

Adaptation of Alternating Currents to Railways. P. M. Lincoln. A statement and discussion of the transportation problem, reviewing the development of electric railroading, the use of direct-current motors, the rotary converter, &c., and discussing the single-phase alternating current motor and its advantages. General discussion. 9000 w. Pro Engrs' Soc of W Penn—April, 1904. No. 64129 D.

Australia.

Sydney's Tramway System. An illustrated article giving an historical review of its growth and progress, fully describing the present electric system, the power, rolling stock, traffic, financial condition, &c. 15800 w. Aust Min Stand—May 19, 1904. No. 63637 B.

Berlin.

The Electric Elevated and Underground Railway of Berlin. Paul Möller. A fully illustrated description of the features of construction, equipment, and operation. 3000 w. Engineering Magazine—August, 1904. No. 63972 B.

The Electric Elevated and Underground Railway at Berlin. An illustrated detailed description of the line, with an account of the project. 5700 w. Trac & Trans—July, 1904. Serial. 1st part. No. 64000 E.

Cars.

New Cars for the Schenectady Railway Company. Illustrated description of fine interurban cars. 2000 w. St Ry Jour—July 16, 1904. No. 63858 C.

Electrification.

Electric Traction on the Metropolitan

Railway. Illustrated detailed description of the work of equipping their lines for electric traction. 12000 w. Tram & Ry Wld—July 14, 1904. No. 64136 B.

Extension.

A New Route from London to Uxbridge. An illustrated account of the latest extension of the Metropolitan Railway, opened July 4. 1400 w. Transport—July 8, 1904. No. 64021 B.

Heavy Traction.

Heavy Electric Traction by Alternating Currents. P. M. Lincoln. Discusses the advantages and the reason of the slow adoption of electricity for heavy traffic in the United States. 2400 w. Can Engr—July, 1904. No. 63853.

High Speed.

The Marienfelde-Zossen High-Speed Trials. Dr. Alfred Gradenwitz. Illustrates and describes the line, and gives an account of the trials of 1901-3. 3800 w. St Ry Rev—July 20, 1904. No. 64103 C.

Interurban.

The Cleveland, Painesville & Ashtabula Electric Railway. Illustrates and describes a line built entirely on private right of way. 4500 w. St Ry Jour—July 16, 1904. No. 63856 C.

The Springfield, Troy and Piqua Electric Railway. An illustrated detailed description of a fine interurban line in Ohio, and its equipment. 5500 w. St Ry Jour—July 23, 1904. No. 64068 C.

The Why and How of Interurban Railways. Guy Morrison Walker. Discusses the advantages of these railways, giving much information of the increase in wealth due to improved transportation, and giving suggestions for developing these roads. 6000 w. St Ry Rev—June 20, 1904. No. 63674 C.

Jungfrau.

The Jungfrau Railway (Le Chemin de Fer de la Jungfrau). L. J. Sidler. An account of the portion of the line already completed and in operation with especial reference to the design of the polyphase electric locomotives. Two articles, two plates. 5000 w. Génie Civil—June 18, 25, 1904. No. 63913 each D.

Narrow Gauge.

St. Georges de Commiers-la Mure Electric Railway. Describes this narrow gauge railway in the French Alps and its rolling stock. It is used mainly for goods traffic. 2300 w. Trac & Trans—July, 1904. No. 64003 E.

Power Station.

Kingsbridge Power Station of the New York City Railway Company. Illustrated detailed description. 4500 w. Eng Rec—July 2, 1904. No. 63660.

New Power Installation of the Twin City Rapid Transit Company. Illustrates and describes the addition to the power equipment recently found necessary for the line connecting Minneapolis and St. Paul, Minn. 4800 w. St Ry Rev—July 20, 1904. No. 64102 C.

The Kingsbridge Power Station of the New York City Railway Company. Illustrated detailed description of this large power plant and its equipment. 6500 w. St Ry Jour—July 2, 1904. No. 63668 C.

The Missouri River Power Station of the Metropolitan Street Railway Company of Kansas City, Mo. Howard Prescott Quick. Explains the situation in Kansas City, giving an illustrated detailed description of the design, and arrangement of the plant, its equipment, &c. Ills. 8000 w. St Ry Rev—June 20, 1904. No. 63-675 C.

The North-Eastern Railway and Carville Power House. Illustrated detailed description of this station. The arrangement of the switch gear is of special interest. 3500 w. Elect'n, Lond—July 1, 1904. Serial. 1st part. No. 63750 A.

Repair Shop.

An Important New Street Railway Repair Shop at Portland, Me. Illustrated description of a new shop installation under construction. 1700 w. St Ry Jour—July 2, 1904. No. 63669 C.

Repair Shop Practice in Columbus, Ohio. Brief illustrated description of these shops and their work. 2000 w. St Ry Jour—July 9, 1904. No. 63778 C.

Rules.

Rules Governing Car Wiring and Equipment of Cars. Gives rules recently adopted by the Underwriters' Nat. Elec. Assn. as embodying the principal precautions necessary in safeguarding cars from fire hazard of their own electrical appliances. 3500 w. St Ry Jour—July 16, 1904. No. 63857 C.

Surface Contact.

Commercial Practicability of Electric Traction by Surface Contacts. C. E. C. Shawfield. A comparison between the overhead system and the surface-contact system. Ills. 5000 w. Elec Engr, Lond—July 1, 1904. Serial. 1st part. No. 63-746 A.

Wheels.

Inspection and Care of Car Wheels. R. B. Stearns. An explanation of the inspection system on the Northwestern Elevated R. R. of Chicago. Ills. 2000 w. St Ry Rev—June 20, 1904. No. 63673 C.

EXPLANATORY NOTE—THE ENGINEERING INDEX.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language*, together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. Certain journals, however, make large extra charges for back numbers. In such cases we may have to increase proportionately the normal charge given in the Index. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

Serial publications are indexed on the appearance of the first installment.

SPECIAL NOTICE.—To avoid the inconvenience of letter-writing and small remittances, especially from foreign countries, and to cheapen the cost of articles to those who order frequently, we sell coupons at the following prices:—20 cts. each or twelve for $2.00, thirty-three for $5, and one hundred for $15.

Each coupon will be received by us in payment for any 20-cent article catalogued in the Index. For articles of a higher price, one of these coupons will be received for each 20 cents; thus, a 40-cent article will require two coupons; a 60-cent article, three coupons; and so on. The use of these coupons is strongly commended to our readers. They not only reduce the cost of articles 25 per cent. (from 20c. to 15c.), but they need only a trial to demonstrate their very great convenience—especially to engineers in foreign countries, or away from libraries and technical club facilities.

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CARD INDEX.—These pages are issued separately from the Magazine, printed on one side of the paper only, and in this form they meet the exact requirements of those who desire to clip the items for card-index purposes. Thus printed they are supplied to regular subscribers of The Engineering Magazine at 10 cts. per month, or $1.00 a year; to non-subscribers, 25 cts. per month, or $3.00 a year.

THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* Boston.
American Electrician. *m.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Jl. of Science. *m.* New Haven, U.S.A.
American Machinist. *w.* New York.
American Shipbuilder. *w.* New York.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. d Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *qr.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Sydney.
Autocar. *w.* Coventry, England.
Automobile. *m.* New York.
Automobile Magazine. *m.* New York.
Automotor Journal. *w.* London.
Beton und Eisen. *qr.* Vienna.
Brick Builder. *m.* Boston.
British Architect. *w.* London.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bulletin American Iron and Steel Asso. *w.* Philadelphia, U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. Soc. Int. d Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bulletin Univ. of Kansas. *b-m.* Lawrence.
Bull. Int. Railway Congress. *m.* Brussels.
California Jour. of Tech. *m.* Berkeley, Cal.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Montreal.
Canadian Mining Review. *m.* Ottawa.
Cassier's Magazine. *m.* New York.
Central Station. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *m.* Chicago.

Electrical Engineer. *w.* London.
Electrical Review. *m.* London.
Electrical Review. *w.* New York.
Electrical World and Engineer. *w.* New York.
Electric Club Journal. *m.* Pittsburg, Pa.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *w.* New York.
Electrochemical Industry. *m.* New York.
Electrochemist and Metallurgist. *w.* London.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Chicago.
Engineering. *w.* London.
Engineering and Mining Journal. *w.* New York.
Engineering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Engineering Review. *m.* London.
Eng. Soc. of Western Penna. *m.* Pittsburg, U.S.A.
Engineering Times. *m.* London.
Fire and Water. *w.* New York.
Foundry. *m.* Cleveland, U. S. A.
Gas Engineers' Mag. *m.* Birmingham.
Gas World. *w.* London.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e. d. Str. Ferr. *w.* Rome.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Ice and Refrigeration. *m.* New York.
Ill. Zeitschr. f. Klein u. Strassenbahnen. *s-m.* Berlin.
Ingenieria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron and Steel Metallurgist. *m.* Boston.
Iron and Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. Am. Foundrymen's Assoc. *m.* New York.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Journal of Sanitary Institute. *qr.* London.
Jour. of South African Assn. of Engineers. *m.* Johannesburg, S. A.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery *b-m.* Fort Monroe, U.S.A.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst.; Worcester, U.S.A.
Locomotive. *m.* Hartford, U. S. A.
Locomotive Engineering. *m.* New York.
Machinery. *m.* New York.
Madrid Cientifico. *t-m.* Madrid.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U. S. A.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Metal Worker. *w.* New York.
Métallurgie. *w.* Paris.
Minero Mexicano. *w.* City of Mexico.
Minerva. *w.* Rome.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci Press. *w.* San Francisco.
Mining Magazine. *m.* New York.
Mining Reporter. *w.* Denver, U. S. A.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
Modern Machinery. *m.* Chicago.
Mouvement Maritime. *w.* Brussels.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *m.* New York.
Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Nineteenth Century. *m.* London.
North American Review. *m.* New York.
Oest. Wochenschr. f. d. Oeff. Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg- & Hüttenwesen. *w.* Vienna.
Ores and Metals. *w.* Denver, U. S. A.
Page's Magazine. *m.* London.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Proceedings Engineers' Club. *qr.* Philadelphia.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Progressive Age. *s-m.* New York.
Quarry. *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago.
Review of Reviews. *m.* London & New York.
Revista d Obras. Pub. *w.* Madrid.
Revista Tech. Ind. *m.* Barcelona.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Gen. des Sciences. *w.* Paris.
Revue Industrielle. *w.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Gen. d Ferrovie. *w.* Florence.
Rivista Marittima. *m.* Rome.
Schiffbau. *s-m.* Berlin.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Engng. *m.* Ithaca, N. Y.
Stahl und Eisen. *s-m.* Düsseldorf.
Stevens' Institute Indicator. *qr.* Hoboken, U.S.A.
Stone. *m.* New York.
Street Railway Journal. *m.* New York.
Street Railway Review. *m.* Chicago.
Tijds. v h Kljk. Inst. v Ing. *qr.* Hague.
Traction and Transmission. *m.* London.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Transport. *w.* London.
Wiener Bauindustrie Zeitung. *w.* Vienna.
World's Work. *m.* New York.
Yacht. *w.* Paris.
Zeitschr. d. Mitteleurop. Motorwagen Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochcemie. *w.* Halle a S.
Zeitschr. f. Elektrotechnik. *w.* Vienna.

CURRENT RECORD OF NEW BOOKS

NOTE—*Our readers may order through us any book here mentioned, remitting the publisher's price as given in each notice. Checks, Drafts, and Post Office Orders, home and foreign, should be made payable to* THE ENGINEERING MAGAZINE.

Alternating Currents.

Alternating Currents: Their Generation, Distribution and Utilization. By George T. Hanchett, M. E. Size, 7½ by 5 in.; pp. iii, 175. Many illustrations. Price, $1. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

A happy medium between the severely mathematical treatises on alternating currents and the popular expositions, is struck by this book, which is written especially for engineers who have a good knowledge of direct-current work, but who have not had an opportunity to familiarize themselves with alternating-current phenomena. The first chapter gives some very ingenious hydraulic and mechanical analogies which are a decided help to a clear conception of the influence of inductance and capacity in alternating-current circuits, and prepare the reader for the chapters which follow. After the general principles of alternating currents are laid down, the single-phase transformer is described; then come chapters on phase difference and vector summation, polyphase circuits and alternating-current measurements. The induction motor, the rotary converter. alternating-current generators and synchronous motors are next described, and the concluding chapters discuss the management of alternating-current machinery. Many diagrams and illustrations of apparatus help to make a clear and successful treatment of a subject which is by no means easy.

Copper.

The Copper Handbook. A Manual of the Copper Industry of the World. Vol. IV. By Horace J. Stevens. Size, 9 by 5 in.; pp. 778. Price, $5. Houghton, Mich.: Horace J. Stevens.

The Copper Handbook is out again, bigger and better than ever. This manual of the world's copper industry has made a place for itself as the authority in its chosen field, and each year it enlarges the sphere of its activity, gathering more facts and giving new information. As heretofore, the principal feature of the book is the chapter containing detailed descriptions, both financial and technical, of the copper mines of the world. This year there are 3,311 copper mines and copper mining companies on the list, the descriptions varying in length from a couple of lines to eleven pages, according to the importance of the property. This number shows an increase of just fifty per cent. over last year, while the chapter has been rewritten throughout and brought up to date. Other chapters are devoted to the history of copper, its geology, chemistry, mineralogy, metallurgy and uses, a very convenient glossary of mining terms, and descriptions of the copper deposits of all parts of the world. The last chapter contains the latest statistics of copper and the copper trade, and the entire work bears evidence of the painstaking care, personal attention and whole-hearted interest of the author.

Cross Ties.

Cross-Tie Forms and Rail Fastenings, with Special Reference to Treated Timbers. (Bureau of Forestry, Bulletin No. 50.) By Hermann von Schrenk. Size, 9 by 6 in.; pp. 70; plates, 5; figures, 71. Washington: U. S. Department of Agriculture.

With the diminishing supply of high-grade timber, owing to the rapid deforestation of some of the most important tree-producing areas in the United States, the railroads have increasing difficulty in obtaining wood for their various purposes and, particularly, for cross ties. Different substitutes for wooden ties, such as steel and concrete, have been suggested and in some cases tried with good results, but for the immediate future, as it has been in the past, wood will be by far the most largely used material for cross ties on American railroads. It becomes, then, of the highest importance to inquire into the methods of using this material to the greatest advantage, and such is the object of the present pamphlet, which discusses in a thoroughly practical, and, at the same time, truly scientific manner, the most economical forms of cross ties and the most efficient ways of fastening the rails to them. A new classification of ties, based upon their exact dimensions, is suggested, and a form, called the "half-round," is recommended for trial and adoption. Screw spikes, wooden screw dowels, wooden and iron tie plates, a convenient machine for driving screw spikes rapidly, and other things connected with rail fastenings are illustrated and described, and accounts of recent European practice in this line are given. The author, Dr. von Schrenk, who is in charge of the division of Forest Products of the United States Bureau of Forestry, has had an extensive experience in the preservative treatment of timber and has done a great deal of good work in interesting the railway and telegraph and telephone companies in that subject, and this latest pamphlet of his should attract the close attention and serious consideration of maintenance-of-way departments in particular and of railroad men in general.

Reinforced Concrete.

Architects' and Engineers' Hand-Book of Reinforced Concrete Constructions. By L. J. Mensch. Size, 7½ by 5 in.; pp. 217; illustrations and figures, 172. Price (paper), $2. Chicago: Cement and Engineering News.

Structures of concrete reinforced by steel or iron are coming into such extensive use, that there is much room for a book giving a clear and simple account of the leading principles and chief applications of this form of construction. Such is the object of the present work, the subject matter of which is drawn largely from the writer's own experience as designer, consulting engineer and contractor for reinforced-concrete structures. After the introduction, there is a description of girders constructed on the Hennebique system and reports of successful tests of girders and floors. The use of reinforced concrete in various kinds of structures is then taken up, including floors; columns, reinforced both by longitudinal rods and by helically-wound wire, on the Considère system; footings for walls; piles and sheet piling; walls; stairs; skeleton buildings; retaining walls; dams; tanks, standpipes, cisterns and reservoirs; grain elevators, coal and ore bins; water pipes, sewers and culverts; chimneys; and bridges. Many illustrations of these applications are shown, and the book is concluded with general specifications for reinforced-concrete construction and the U. S. Engineer Corps specifications for Portland cement.

Tool Steel.

Points for Buyers and Users of Tool Steel. By Geo. W. Alling, M. E. Size, 8 by 5½ in.; pp. 224; illustrations, 65. Price, $2. New York: David Williams Company.

As indicated by its subtitle, this book is a review of the main sources of trouble met with by consumers of tool steel, and contains practical suggestions for avoiding them. The first part is directed especially to purchasing agents, with a view to assisting them in deciding what grade of steel is best suited to a particular use, and in discriminating among the great variety of steels offered to them. There are descriptions of how the different steels are made; it is shown why good steel is high priced, and why cheap steel is expensive to use in most cases, although under certain circumstances the cheaper grades may be employed to advantage. New methods and processes are criticized, and considerable attention is given to defects in steel, and the ways in which they are produced and detected. Part second is of special interest to the tool maker, the mechanic and other users of steel. It contains a great deal about annealing, hardening and other ways of working steel, methods of testing the quality and uniformity of steel, the grinding of cutting tools, and much other useful information. One chapter is devoted to the new high-speed steels, their use and treatment, another contains definitions of steel workers' terms, and there are useful tables and concise data. The illustrations are very instructive, and the whole work is an extremely practical one, being full of examples drawn from actual experience.

BOOKS RECEIVED.

The Theory of the Lead Accumulator. By Dr. Friedrich Dolezalek. Translated by Carl L. von Ende, Ph. D. Price, $2.50. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

The Floods of the Spring of 1903, in the Mississippi Watershed. Bulletin M., U. S. Weather Bureau. By H. C. Frankenfield. Washington: Weather Bureau.

Memoria de Obras Públicas (Report on Public Works in Cuba). by Manuel L. Diaz, Secretary of Public Works of the Republic of Cuba. Havana: Department of Public Works.

Technical Mechanics. By Edward R. Maurer. Price, $4. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

Irrigation Engineering. By Herbert M. Wilson, C. E. $4. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

A Text-Book of Electrical Machinery. Volume I. Electric, Magnetic, and Electro-Static Circuits. By Harris J. Ryan, M. E. Henry H. Norris, M. E., and George L. Hoxie, M. M. E., Ph. D. Price, $2.50. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

Industrial Uses of Water. By H. de la Coux. Translated from the French and revised by Arthur Morris. Price, 10s. 6d. ($4.50). London: Scott, Greenwood & Co. New York: D. Van Nostrand Co.

Graphic Statics, with Applications to Trusses, Beams and Arches. By Jerome Sondericker, B. S., C. E. Price, $2. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

NEWS SUPPLEMENT

The Engineering Magazine—April, 1904

Coming Society Meetings.

Air-Brake Association. Sec.: F. M. Nellis, 174 Broadway, New York. Annual meeting May 10, at Buffalo.

American Electrochemical Society. Sec.: C. J. Reed, 929 Chestnut St., Philadelphia. Next meeting April 7 to 9, at Washington, D. C.

American Institute of Electrical Engineers. Sec.: Ralph W. Pope, 95 Liberty St., New York. Next meeting, April 22, at Chemists' Club, 108 W. 55th St. Papers on Alternating-Current Generaors.

American Institute, Polytechnic Section. Sec.: George Whitefield, Jr., 19 W. 44th St., New York. Meetings on first and third Thursdays of each month, from October to May, inclusive.

American Railway Association. Sec.: W. F. Allen, 24 Park Place, New York. Next meeting, April 27, at New York.

American Railway Master Mechanics' Association. Sec.: J. W. Taylor, 667 Rookery, Chicago. Meeting, June 27-29, Saratoga Springs, N. Y.

American Society of Civil Engineers. Sec.: C. W. Hunt, 220 W. 57th St., New York. Regular meetings, first and third Wednesdays of each month, except July and August.

American Society of Mechanical Engineers. Sec.: Prof. F. R. Hutton, 12 W. 31st St., New York. Joint meeting with the Institution of Mechanical Engineers of Great Britain, May 31 to June 3, at Chicago.

American Water-Works Association. Sec.: J. M. Diven, Elmira, N. Y. Annual convention, June 6 to 10, at St. Louis.

Boston Society of Civil Engineers. Sec.: S. E. Tinkham, 715 Tremont Temple. Regular meetings on third Wednesday of each month, except July and August.

Brooklyn Engineers' Club. Sec.: J. Strachan, 191 Montague St. Regular meetings on second Thursday of each month.

Canadian Railway Club. Sec.: W. H. Rosevear, Jr., Montreal. Regular meetings on first Tuesday of each month, except June, July and August.

Canadian Society of Civil Engineers. Sec.: Prof. C. H. McLeod, 877 Dorchester St., Montreal. The General Section and the Electrical, Mechanical and Mining Sections meet on different Thursdays.

Central Railway Club. Sec.: Harry D. Vought, 62 Liberty St., New York. Regular meetings on second Friday of January, March, May, September, and November, Hotel Iroquois, Buffalo.

Chicago Electrical Association. Sec.: W. B. Hale, Monadnock Building. Regular meetings on first and third Fridays of each month, from October to May.

Civil Engineers' Club of Cleveland. Sec.: Joseph C. Beardsley, 689 The Arcade. Regular meetings on second and fourth Tuesdays of each month.

Civil Engineers' Society of St. Paul. Sec.: G. S. Edmondstone. Regular meetings on second Monday of each month.

Engineering Association of the South. Sec.: Robt. L. Lund, 2102 Hayes St., Nashville, Tenn. Regular meetings on second Thursday of each month at the Berry Block.

Engineers' Club of Chicago. Sec.: B. W. Thurtell, 1223 New York Life Building. Regular meetings on first and third Tuesdays of each month.

Engineers' Club of Cincinnati. Sec.: J. F. Wilson, P. O. Box 333. Regular meeting on third Thursday of each month.

Engineers' Club of Columbus (Ohio). Sec.: H. M. Gates, 12½ North High St. Regular meetings on third Saturday of each month.

Engineers' Club of Minneapolis. Sec.: Jas. B. Gilman, American Bridge Co. Regular meetings on third Monday of each month.

Engineers' Club of Philadelphia. Sec.: J. O. Clarke, 1122 Girard St. Regular meetings on first and third Saturdays of each month, except July and August.

Engineers' Club of St. Louis. Sec.: H. J. Pfeifer, 920 Rialto Bldg. Regular meetings on first and third Wednesdays of each month.

Engineers' Society of Western New York. Sec.: H. B. Alverson, 533 Ellicott Square, Buffalo. Regular meetings on first Tuesday of each month.

Engineers' Society of Western Pennsylvania. Sec.: Chas. W. Ridinger, 410 Penn. Ave., Pittsburg. Regular meetings on third Tuesday of each month.

Franklin Institute. Sec.: Dr. Wm. H. Wahl, 15 South 7th St., Philadelphia. General meetings on third Wednesday of each month, except July and August. General section meetings every Thursday.

Honolulu Engineering Association. Sec.: G. F. Bush, Honolulu, Hawaii.

International Electrical Congress. Sec.: Dr. A. E. Kennelly, Harvard University, Cambridge, Mass. Meeting, Sept. 12 to 17, at St. Louis.

International Engineering Congress. Sec.: Charles Warren Hunt, 220 W. 57th St., New York. Meeting Oct. 3 to 8, at St. Louis.

Iowa Electrical Association. Sec.: W. S. Porter, Eldora. Convention, April 13 and 14, at Des Moines.

Iowa Railway Club. Sec.: P. B. Vermillion, Des Moines, Iowa. Regular meetings on third Tuesday of each month.

Louisiana Engineering Society. Sec.: G. W. Lawes, 806 Gravier St., New Orleans. Regular meetings on second Monday of each month.

Master Car Builders' Association. Sec.: J. W. Taylor, 667 Rookery, Chicago. Meeting, June 22-24, Saratoga Springs, N. Y.

Montana Society of Engineers. Sec.: Clinton H. Moore, Butte, Mont. Regular meetings on second Saturdays.

National Electric Light Association. Sec.: Ernest H. Davis, 136 Liberty St., New York. Annual convention, May 24 to 27, at Boston.

New England Railroad Club. Sec.: Edw. L. Janes, Back Bay P. O., Boston. Regular meetings, second Tuesday in each month, except June, July, August and September, at Pierce Hall, Copley Square.

New York Electrical Society. Sec.: Geo. H. Guy, 114 Liberty St., New York. Meetings monthly, on different Wednesdays, at the American Institute, 19 W. 44th St.

New York Railroad Club. Sec.: F. M. Whyte, Grand Central Station, N. Y. City. Regular meetings on third Friday of each month, except June, July and August, at Carnegie Hall, 154 W. 57th St., New York.

New York Street Railway Association. Sec.: W. W. Cole, Elmira. Annual meeting, Sept., at Utica.

North-West Railway Club. Sec.: T. W. Flannagan, Minneapolis, Minn. Regular meetings on first Tuesday after second Monday of each month, except June, July and August, alternating between Minneapolis and St. Paul.

Pacific Coast Electrical Transmission Association. Sec.: Geo. P. Low, 237 Cherry St., San Francisco. Annual convention, third Tuesday in June. Intermediate meetings subject to call.

Pacific Coast Railway Club. Sec.: C. C. Borton, West Oakland, Cal. Regular meetings on third Saturday of each month at San Francisco and other cities.

Pacific Northwest Society of Engineers. Sec.: Prof. M. Roberts, Seattle, Wash. Meetings monthly in Chamber of Commerce rooms, Seattle.

Railway Club of Pittsburg. Sec.: J. D. Conway, P. & L. E. R. R., Pittsburg, Pa. Regular meetings on fourth Friday of each month, except June, July and August, at Hotel Henry.

Railway Signal Association. Sec.: B. B. Adams, 83 Fulton St., New York. Regular meetings on second Tuesday of January, March, May, Sept. and Nov.

Richmond Railway Club. Sec.: F. O. Robinson, 8th & Main Sts., Richmond, Va. Regular meetings on second Thursday of each month, except June, July and August.

Rocky Mountain Railway Club. Sec.: M. M. Currier, Colorado City. Regular meetings on second Tuesday of each month, at Union Depot, Denver.

St. Louis Railway Club. Sec.: E. A. Chenery, Union Station, St. Louis. Regular meetings on second Friday of each month, except July and August.

Society of Chemical Industry, New York Section. Sec.: H. Schweitzer, 40 Stone St. Meetings on third Friday after the first Monday of each month, at Chemists' Club, 108 W. 55th St.

Southern and Southwestern Railway Club. Sec.: W. A. Love, Atlanta, Ga. Regular meetings on third Thursday of Jan., April, Aug. and Nov., at Atlanta.

Technical Society of the Pacific Coast. Sec.: Otto von Geldern, 31 Post St., San Francisco. Regular meeetings on first Friday of each month.

Texas Railway Club. Sec.: T. H. Osborne, Pine Bluff, Ark. Regular meetings on third Monday of April and September.

Toledo Society of Engineers. Sec.: L. M. Gram, 519 Gardner Building, Toledo, O. Meetings on third Friday of each month in National Union Building.

Western Railway Club. Sec.: J. W. Taylor, 667 Rookery, Chicago. Meetings on third Tuesday of each month, except June, July and August, Auditorium Hotel, Chicago.

Western Society of Engineers. Sec.: J. H. Warder, Monadnock Block, Chicago. Regular meetings on first Wednesday and extra meetings on third Wednesday of each month, except July and August.

Personal.

—Mr. Charles C. Brown, formerly assistant to Mr. O. H. Taylor, general passenger agent, N. Y., N. H. & H. R. R., Marine District, has been appointed general passenger and ticket agent of the Bangor & Aroostook Railroad Company, with office at Bangor, Maine.

—Mr. Konrad Meier, who was for ten years the chief assistant to Mr. A. R. Wolff, has opened an office at No. 27 East 22nd St., New York, as a consulting heating and ventilating engineer. He has lately published a pamphlet entitled, "Reflections on Heating and Ventilating Engineering."

—Mr. W. K. Palmer has removed his engineering offices to Suite 402, the Lyceum Building, Kansas City, Mo. In the new offices ample space and special facilities, together with the services of a corps of able and experienced engineers, afford exceptional advantages for the prompt preparation of engineering plans, specifications, estimates and reports, and for the thorough supervision of engineering construction.

—Mr. Henry R. Dalton, Jr., has been elected president of the Baush Machine Tool Co., of Springfield, Mass., to take the place of Mr. W. H. Baush, resigned; and Mr. C. J. Wetsel has been elected treasurer, to fill the vacancy caused by the resignation of Mr. David Hunt, Jr.

—Mr. Philetus W. Gates and Mr. Henry W. Hoyt, respectively general superintendent and second vice-president of Allis-Chalmers Company, are about to retire from active participation in the management of that company. Mr. Gates was president and Mr. Hoyt secretary and general manager of Gates Iron Works for fifteen years prior to the incorporation of Allis-Chalmers Company in 1901. They have been prominently connected with the manufacturing interests of Chicago and have taken an active part in all of the manufacturers' associations. Messrs. Hoyt and Gates, after a well earned vacation spent in traveling, will re-engage in business in Chicago.

—Mr. George Frederick Gilbert died of typhoid fever at St. Mary's Hospital, Rochester, N. Y., on Jan. 12th, aged 42 years. In 1896, he became connected with the H. W. Johns-Manville Co., New York, and was their general sales agent for Northern and Western New York. He also represented the company in connection with work for the State Government.

Industrial Notes.

—An International Electrical Congress vill be held at the St. Louis Exposition luring the week beginning September 12th, o which official delegates will be sent by he governments of the principal countries f the world. Besides these delegates, there vill be a large number of members of the Congress, made up of electrical engineers nd others interested in electrical matters. Up to March 18, there were 1,128 acceptnces of membership, and 136 papers had een promised. Each person joining the ongress and paying the fee of $5, will reive an engraved certificate of membership, and will be entitled to a copy of the proceedings, which will probably be issued in three volumes, of 800 pages each. The secretary of the Congress is Prof. A. E. Kennelly, Harvard University, Cambridge, Mass., and the treasurer is Mr. W. D. Weaver, 114 Liberty St., New York.

—The Chicago Meeting of the American Society of Mechanical Engineers is to be a joint session of that association and the Institution of Mechanical Engineers of Great Britain. Nearly two hundred members of the British Institution have expressed their intention of coming to America, and taking part in this joint meeting. It is the purpose of these visitors not only to attend an American Meeting, and thereafter visit the St. Louis Exposition, but to make the American visit the occasion of excursions to points of technical and manufacturing interest all through the United States.

—The Warren Brothers Company, of Boston and New York, have been awarded a contract in Cohoes, N. Y., for 22,000 square yards of their patented bitulithic pavement, at $2.48 per square yard, the pavement to be laid in Ontario, Vliet and Mangan streets. Their bid was within the engineer's estimate, and in preference to other paving materials, the bitulithic pavement was the practically unanimous choice of the taxpayers, after a thorough investigation of its merits.

—The Stirling Co., the water-tube boiler manufacturers, have removed their Cincinnati offices from the Neave building to the new concrete Ingalls building, Fourth and Vine Streets.

—The Carpenter Steel Co., in spite of their temporary embarrassment, are still actively engaged in the steel business. Their works are being run by Mr. Robert E. Jennings, as receiver, and their trade, considering the dullness of the times, was never better. They are constantly making and carrying in stock a full assortment of "Zenith," air-hardening and other special steels, out of which they can supply all orders promptly, and the quality of their material is making customers for them in every part of the country.

—The Cost-System and Auditing Company, of New York, have enlarged their business so much of late that they find it necessary to increase their facilities for handling it, and will therefore remove their office to commodious quarters at 52 Broadway.

—The French Society of Civil Engineers are about to make a collection of plans and designs of engineering works, machines, etc., which will be properly classified and placed in their library. These plans willl be contributed by the members and others, and will be of great service to all the members and particularly to the younger associates.

—A. Wyckoff & Son Co., of Elmira, N. Y., manufacture a patent steam-pipe covering for preventing heat losses, which is especially suited for underground and exposed conditions and is permanently waterproof. They also make wood pipes for fresh water supply and for carrying acidulated liquors and mine waters.

—A very important installation of Pelton water wheels was recently completed near Placerville, Cal., for the American River Electric Company, consisting of two double Pelton units of a capacity of 2,500 horse power, operating under a head of 575 feet. This plant is situated on the American River, within a few miles of the State capital, Sacramento, and will generate electricity for near-by towns.

—The Nernst Lamp Company has recently closed contracts for the installation of 165 Nernst lamps in the Washington National Bank Building and 75 lamps for the Pittsburg Supply Company, at Pittsburg, Pa. They have also succeeded in securing the adoption of Nernst lamps by the Municipal Electric Light plant of Silverton, Col., in competition with enclosed arc lamps.

—One of the most interesting features of the new plant now being erected by the B. F. Sturtevant Co., at Hyde Park, Mass., is an elaborate testing plate for its engines. With an output of a thousand engines or more per year this is the essential climax of a careful system of manufacture and testing. The plate, or more properly the plates, will be supported upon a series of heavy parallel walls between which steam and exhaust pipes are carried so that at almost any point in the entire area of the floor, measuring about 30 feet by 60 feet, steam and exhaust connections may be made to any engine. Testing facilities will be provided, and a transfer crane overhead will make it very simple to locate or remove the engines. The same crane will transport them to the packing department, and thence load them directly upon cars which traverse the end of the building.

—The National Electric Company, successors to the Christensen Engineering Company, manufacturers of air-brake and electrical machinery, have just moved their executive offices and engineering department to their new building, located at their Milwaukee works. This building is constructed of cement blocks 2 feet long by 1 foot high and is 200 feet long by 66½ feet wide. Extensions and improvements are also being made in their shops, to supply the necessary facilities for handling the company's constantly increasing business.

—The Canada Corundum Company, Limited, of Toronto, have completed their new mill and are ready to make contracts to furnish customers with from one to three years' supply of pure Craig Mine corundum. Three years ago this product was first put upon the market. The demand for it has steadily increased, and last spring the erection of a new plant was begun, which is the largest abrasive mill ever erected in any country. Its capacity is from 5,000 to 8,000 tons per year of finished product. This product is absolutely uniform and orders can be duplicated indefinitely.

—The Underfeed Stoker Co. of America, of Chicago, issues *The Publicity Magazine,* devoted to the interests of the Jones Stoker. The February number contains illustrations and much information of interest to the managers of steam and power plants and to other users of coal under boilers.

—The Keasby & Mattison Co. have opened a department in their office, No. 84 John St., New York, for the direct sale of their technical products, which have been heretofore very generally handled by the trade of New York City and vicinity. These products comprise every style of their well-known magnesia sectional coverings, a most efficient heat insulator, containing 85 per cent. of pure carbonate of magnesia, this type of steam-pipe and boiler insulation having been originated by them. Their products also include standard asbestos moulded covering, absolutely free from harmful plaster of paris; asbestos interlined felt coverings; asbestos air-cell coverings; corrugated wool felt coverings; asbestos building papers; asbestos fibre felts; asbestos packings, cloths and textiles of every possible description; theatre curtains of asbestos, gloves, mittens, stove mats, and many other asbestos articles.

—Among the most important orders for installations of Foster steam superheaters reported by the Power Specialty Company, of 126 Liberty St., New York, are those of the separately fired type in connection with the boilers of the Laclede Power Co., St. Louis, Mo., and the Williamsport Passenger Railway Co., Williamsport, Pa.; while of the combined type contracts have been awarded for Babcock & Wilcox boilers and Foster superheaters for the United States Naval Gun Factory, at Washington, and for the Columbia Improvement Co., Terre Haute, Ind., of which Messrs. Stone & Webster, Boston, are the engineers.

—The summer school of the University of Colorado, at Boulder, thirty miles north of Denver, will be open from June 20 to July 30.

—A convention of branch managers, department managers and salesmen of the H. W. Johns-Manville Co., was in session from Monday, February 15th to Saturday, February 20th. Representatives to the number of about thirty-five from all parts of the country, were present, the company having branches in New York, Milwaukee, Chicago, St. Louis, Boston, Philadelphia, Cleveland, Pittsburg, New Orleans, London. The delegates first met in Hartford, Conn., where they were the guests of the Johns-Pratt Co., manufacturer of the famous Sachs "Noark" enclosed fuses, line materials and other electrical goods for which the H. W. Johns-Manville Co., are sole agents. The object of the convention was to bring all branches into closer touch with each other and to give opportunity for a general discussion of all the enormously varied lined manufactured by this company.

—Plans for the Model Foundry, to be carried on in connection with the St. Louis Exposition, are now completed and it is expected that the construction of the building for that purpose will begin very soon. An unexpected delay occurred which has held back the promoters of the plan; but it is expected now that no further obstacles will be encountered to the carrying out of the design as originally formed. President Engler, of the Worcester Polytechnic Institute, has been asked to name a man to take charge of the erection of the building and of the foundry itself, after it is once in operation; and, as has been previously announced, the entire charge of the foundry throughout the summer will be in the hands of the Worcester Polytechnic Institute.

—Marine Iron Works (W. G. Nourse, Manager) of Chicago, recently wrote a letter to one of their New York customers, from which the following is an extract: "There is a feature in connection with this marine engine business in the small and medium size work (20 to 500 H. P.) that you will understand, viz.: If a concern which for a number of years had devoted their attention exclusively to their work, taking a real interest in it and keeping their more or less old patterns as nearly modern as circumstances would permit were to be totally wiped out by fire, and all of the patterns destroyed, you can realize that an ideal opportunity would be offered for either quitting entirely or starting fresh. If the latter plan is adopted, it presents the advantage of incorporating into new patterns all that was best in the old, together with many good features which the old designs would not permit. It was this latter plan that we selected and have been following for the past two years, and although it has been "hard sledding" at times, and at first a tremendous loss to us, it is proving, and we believe will continue to prove, a positive benefit. To-day our line of engine patterns, especially in compounds and triple expansions, is at least one hundred per cent. better and more complete than those that went up in smoke two years ago. If we could make these facts known to a larger proportion of the intelligent buyers of such machinery, it would be of value to all parties concerned, not excepting the users. You know, in fact everyone familiar with marine machinery within the range of work referred to knows, that no concern in the country could afford to deliberately destroy old patterns, neither is it possible to make such changes as will always keep them up-to-date, and it requires some real calamity to compel builders to make an entire new and complete line. It might seem possible for a newly organized company to do this, but they could not have had that associated experience so necessary in discussing and deciding upon seemingly minor but really important details of construction."

—In a paper read by Mr. Perez M. Stewart before the International Association of Fire Engineers, it was stated that the best protection for wall openings in buildings "is to be found in the fireproof window glazed with wire glass, set in a sash and window frame of wood covered with metal, or of hollow metal entirely. Wire glass is made either with a translucent or polished surface, and the wire reinforcement, embedded in the glass itself, although keeping the window intact against the attack of a fire of almost any intensity, may be broken readily by the fireman when it becomes necessary to enter the building or introduce a fire stream. Among the recent important fires showing the efficiency of wire glass windows in reducing the exposure hazard, may be cited the Armour Lard Refinery, Union Stock Yards, Chicago; the Case Plow Works, in Racine, Wis., and the Mitchell Wool Warehouse, in Philadelphia. In each of these instances the spread of fire to very valuable properties standing but a few yards distant was prevented through the resistance offered by wire glass windows in the walls of the adjoining building."

—An International Engineering Congress, under the auspices of the American Society of Civil Engineers, will be held at the Universal Exposition, St. Louis, during the week of October 3d to 8th, 1904. The Congress will be one of a series of International Scientific Congresses to be held at the Exposition under the general authority and with the co-operation of the Director of Congresses. The development of engineering science during the past decade has been so rapid and has extended over so wide a field that the Universal Exposition at St. Louis seems to be a fitting time at which to review the work of the past and obtain an authoritative epitome of present practice. The object of the Congress is to secure a thorough international consideration of certain branches of engineering work which have been selected with special reference to their present interest and importance. In order to facilitate the work of the Congress and to insure the presentation of topics in a systematic manner, the Committee has prepared a list of the subjects which have been selected for review and discussion, it being understood that the list of subjects proposed is somewhat tentative, and may be slightly modified as the details of the programme are perfected. As a basis for discussion at the sessions of the Congress, the Committee has invited engineers specially qualified in each of the various branches to prepare a review of the development during the past ten years in that branch in the United States, together with a summary of present practice. Engineers in other countries, experienced in these various lines, will be specially invited to prepare similar papers presenting a review and summary of practice in their respective countries. It is proposed to print these papers in advance, in order that a full discussion at the various sessions may be elicited without giving up any time to the reading of papers at the Congress. All engineers in the United States and in all other countries are invited to become members of the Congress, to attend the sessions, and to take part in the discussions; or, if unable to attend, to forward written communications on any of the selected subjects. It is not expected that delegates will be formally appointed, it being intended that an opportunity to attend shall be afforded to any who may wish to become members of the Congress. The papers, together with the discussions upon them, will be collated and published in one or more volumes by the American Society of Civil Engineers. The membership fee in the Congress will be $5.00, which will entitle the member to participate in the Congress and to receive a copy of the published proceedings. Membership may be secured by forwarding this fee, with name and address, to the Secretary of the Committee, Charles Warren Hunt, 220 West 57th St., New York City, who will issue a receipt therefor. Each member will receive all notices, programmes, etc., issued in advance of the Congress.

NEW CATALOGUES AND TRADE PUBLICATIONS

These catalogues may be had free of charge on application to the firms issuing them. Please mention The Engineering Magazine when you write.

Air Compressors.

Booklet containing valuable information regarding compressed air installations and descriptions and illustrations of air compressors, air valves, governors, intercoolers and other apparatus. 6 by 3½ in.; pp. 31. American Air Compressor Works, 26 Cortlandt St., New York.

Calculagraph.

Booklets describing the use of the calculagraph—which prints a record of the elapsed time in any operation, and, if desired, the time value, in dollars and cents—in telephone exchanges, factories and workshops, billiard rooms, and other places where it is desirable to measure time accurately and keep a permanent record of it. 6½ by 3½ in. Calculagraph Company, 9-13 Maiden Lane, New York.

Centrifugal Pumps.

Pamphlet, with well illustrated descriptions of the newest designs of turbine centrifugal pumps, for lifts up to 2,000 feet, and of conoidal and volute centrifugal pumps for more moderate heads. 9 by 6 in.; pp. 48. Henry R. Worthington, 114-118 Liberty St., New York.

Compressors.

Catalogue, with descriptions and half-tone illustrations of single, two, and three-stage air compressors, natural-gas compressors, blowing engines, intercoolers, and details of compressors for any service. 6½ by 10¾ in.; pp. 50. Nordberg Manufacturing Co., Milwaukee.

Concrete Mixer.

Booklet, with illustrated description of the Autometric concrete mixer, which automatically measures the ingredients, mixes them in any proportions desired, dry and wet, and discharges the concrete. 3½ by 6 in.; pp. 16. Campbell & Marsh, Milwaukee.

Conveying Machinery.

Booklet No. 6, containing illustrations and descriptions of conveying and elevating machinery for boxes, barrels, bales, packages and other kinds of freight, and coal handling and screening machinery. 8½ by 5¾ in.; pp. 45. Borden & Selleck Company, Chicago.

Countershaft.

Catalogue D, giving an illustrated description of the one-belt reversing counter-shaft, designed to operate screw machines, monitors, engine lathes and other machine tools requiring a forward and a reverse drive, without the use of two belts. 6 by 9 in.; pp. 16. The Smith Countershaft Co., Melrose, Mass.

Electric Instruments.

Bulletins Nos. 15 to 24, inclusive, containing illustrations, descriptions and prices of direct-current voltmeters and ammeters of various types, including illuminated-dial, portable, automobile and other patterns. 9 by 5¾ in.; pp. 4. Empire Electrical Instrument Co., 654 Hudson St., New York.

Electric Tools.

Booklet, containing illustrations and descriptions of the "Willey" electrically driven breast drills and portable grinders for center grinding and a wide range of other work. 6 by 3½ in.; pp. 16. Jas. Clark, Jr., & Co., Louisville, Ky.

Gas Engines.

P Catalogue, with descriptions and illustrations of "Charter" gas and gasoline engines and their applications to pumping, hoisting, sawing, propelling boats and other uses, and illustrated descriptions of "Sterling" portable gasoline engines. 6 by 9 in.; pp. 47. Also, sheets of testimonials from many users. Charter Gas Engine Co., Sterling, Ill.

Gears.

Catalogue No. 27, with flexible cloth binding, containing illustrated descriptions and price-lists of Walker machine-molded and pattern gears of every description, and illustrations of other power-transmitting, elevating and conveying machinery, together with useful information and tables. 9 by 6 in.; pp. 144. H. W. Caldwell & Son Company, Chicago.

Graphite.

Booklet devoted to Dixon's graphite pipe-joint compound, as put up in collapsible tubes, for screw joints of every sort, gaskets, bolts, nuts, and steam, water, gas, gasoline and oil piping. 6¼ by 3¼ in.; pp. 6. Joseph Dixon Crucible Co., Jersey City, N. J.

Graphite Paint.

Booklet describing the manufacture of graphite paint and its application to steel buildings, docks and piers, breweries, refrigerating machines, roofs, smokestacks, bridges and viaducts, power plants, ornamental iron work and other structures and machines; with many illustrations. 6 by 3 in.; pp. 16. Detroit Graphite Mfg. Co., Detroit.

Ice Machines.

Catalogue D, with illustrations and descriptions of many varieties of steel ammonia fittings for refrigerating machinery, and of other ice factory supplies. 9 by 6 in.; pp. 81. The Triumph Ice Machine Co., Cincinnati.

Indicator.

Circular, containing an illustrated description of the Star improved steam engine indicator, with an outside spring, which is elongated when in action. 9¼ by 6 in.; pp. 4. Star Brass Manufacturing Co., Boston.

Locomotives.

"Record of Recent Construction," No. 44, a pamphlet containing handsome illustrations and descriptions, in French and English, of Atlantic, consolidation, inspection and various other types of locomotives, built lately at the Baldwin Works. 6 by 9 in.; pp. 32. Baldwin Locomotive Works, Philadelphia.

Mining Machinery.

Large illustrated catalogue of hoisting engines and boilers, coal, coke and rock breakers and crushers, screens, coal tipples, mine cars, barrows, and a great many other kinds of mining machinery and apparatus. 12 by 9 in.; pp. 72. Kenney & Company, Scottdale, Pa.

Oil Burners.

Catalogue No. 4, containing illustrations and descriptions of Branch oil burners, for boiler furnaces and automobiles, for domestic use and other purposes, and of Branch steam traps. 6 by 9½ in.; pp. 24. Also, "Automobile Bulletin" No. 3 and circulars devoted to the Branch combined condenser and oil eliminator for steam vehicles and to various styles of oil burners. The National Oil Burner and Equipment Co., St. Louis.

Packings.

Catalogue, containing descriptions, illustrations and prices of ring, spiral, sheet and other forms of packing, made of rubber, cotton, flax, asbestos and other materials, and for use with steam, ammonia and water. 4½ by 6 in.; pp. 53. The Crandall Packing Co., Palmyra, N. Y.

Pumps.

General catalogue for 1904 of Knowles pumping machinery, including boiler feed pumps, mining pumps, air pumps, vacuum pumps, hydraulic-pressure pumps, wrecking and irrigating pumps, fire pumps and many other varieties, both steam and electric driven. Also, useful information and telegraph code. 7 by 5½ in.; pp. 137. Knowles Steam Pump Works, 114 Liberty St., New York.

"Pump Data" No. 4, a bulletin illustrating and describing the Aldrich vertical triplex pump operated by a high-speed electric motor through a silent chain drive. 9 by 6 in.; pp. 4. The Allentown Rolling Mills, Allentown, Pa.

Rail Joint.

Pamphlet, with illustrations and descriptions of the Heil improved cast-welded rail joint and the steel-jacket cast-weld rail joint, particularly adapted to electric railways, both city and interurban; of the Heil welding outfits, propelled by either electricity or steam; and of the sand-blast rail cleaner. 6¾ by 4¾ in.; pp. 18. The Heil Rail Joint Welding Co., Milwaukee, Wis.

Shaft Hangers.

Booklet, with illustrations and descriptions of the American Pioneer pressed steel shaft hangers, post hangers and floor stands, which have several valuable improvements, and combine maximum strength with minimum weight. 6 by 3½ in.; pp. 20. Standard Pressed Steel Co., Philadelphia.

Silicate Stone.

Illustrated pamphlet, reprinted from *The Magazine of Commerce,* describing the process of making a first-rate artificial building stone from sand and lime, and showing its many uses. 9½ by 7¼ in.; pp. 7. Also, an article reprinted from the *Brooklyn Eagle,* devoted to the same subject. Silicate Stone Company, 39 Wall St., New York.

Steam Engines.

Catalogue, containing well-illustrated and comprehensive descriptions of Nordberg Corliss steam engines and their details, jet and surface condensers, the Milwaukee feed-water heater and purifier, tables and useful information concerning steam engines and their installation. 6¾ by 10¼ in.; pp. 75. Nordberg Manufacturing Co., Milwaukee.

Steam Shovel.

Pamphlet, containing description, specifications and illustrations of a 30-ton traction steam shovel, with 1¼-cubic-yard dipper, suitable for a great variety of work, and constructed in a manner which combines great strength, capacity, propelling power and ease of handling. 10¾ by 6¾ in.; pp. 11. The Ohio Steam Shovel Co., Toledo, O.

Steam Traps.

Steam bulletin No. 10, containing illustrations and descriptions of the Branch steam trap, steam separators, the Klinger water glass, valves, couplings, and other steam supplies. 6 by 9½ in.; pp. 8. The National Oil Burner and Equipment Co., St. Louis.

Storage Batteries.

Bulletin No. 81, giving an illustrated description of the installation of Chloride accumulators in the power station of the San Francisco, Oakland & San Jose Railway Co., and the advantages resulting from their use. 10½ by 8 in.; pp. 4. The Electric Storage Battery Co., Philadelphia.

Tapes.

Catalogue, containing illustrations, descriptions and prices of all kinds of measuring tapes, made of steel, linen and other materials, in cases and on frames. 5½ by 3¼ in.; pp. 28. The Lufkin Rule Co., Saginaw, Mich.

Tools.

Catalogue for 1904, in cloth binding, containing illustrations and descriptions of milling machines, grinding machines, automatic gear-cutting machines, screw machines, cutters, accurate test tools and gauges, machinists' tools and many other machines and tools. 6 by 3½ in.; pp. xxii, 482. Brown & Sharpe Mfg. Co., Providence, R. I.

Well Machinery.

General catalogue, containing illustrations and descriptions of well-sinking outfits, prospecting, pumping and irrigating machinery, air compressors, Chapman's air water lift, gasoline and steam engines, boilers, and other kinds of well machinery, tools and fittings. 9 by 6 in.; pp. 160. The American Well Works, Aurora, Ill.

NEWS SUPPLEMENT

The Engineering Magazine—May, 1904

Coming Society Meetings.

Air-Brake Association. Sec.: F. M. Nellis, 174 Broadway, New York. Annual meeting May 10, at Buffalo.

American Boiler Manufacturers' Association. Sec.: J. D. Farasey, Cleveland. Next meeting Oct., at St. Louis.

American Foundrymen's Association. Sec.: Dr. Richard Moldenke, P. O. Box 432, New York. Convention June 7-9, at Indianapolis, and June 10, at St. Louis.

American Institute of Electrical Engineers. Sec.: Ralph W. Pope, 95 Liberty St., New York. Annual meeting, May 17, New York. Convention, Sept. 12-17, St. Louis.

American Institute, Polytechnic Section. Sec.: George Whitefield, Jr., 19 W. 44th St., New York. Meetings on first and third Thursdays of each month, from October to May, inclusive.

American Railway Master Mechanics' Association. Sec.: J. W. Taylor, 667 Rookery, Chicago. Meeting, June 27-29, Saratoga Springs, N. Y.

American Society of Civil Engineers. Sec.: C. W. Hunt, 220 W. 57th St., New York. Regular meetings, first and third Wednesdays of each month, except July and August.

American Society of Mechanical Engineers. Sec.: Prof. F. R. Hutton, 12 W. 31st St., New York. Joint meeting with the Institution of Mechanical Engineers of Great Britain, May 31 to June 3, at Chicago.

American Water-Works Association. Sec.: J. M. Diven, Elmira, N. Y. Annual convention, June 6 to 10, at St. Louis.

Boston Society of Civil Engineers. Sec.: S. E. Tinkham, 715 Tremont Temple. Regular meetings on third Wednesday of each month, except July and August.

Brooklyn Engineers' Club. Sec.: J. Strachan, 191 Montague St. Regular meetings on second Thursday of each month.

Canadian Railway Club. Sec.: W. H. Rosevear, Jr., Montreal. Regular meetings on first Tuesday of each month, except June, July and August.

Canadian Society of Civil Engineers. Sec.: Prof. C. H. McLeod, 877 Dorchester St., Montreal. The General Section and the Electrical, Mechanical and Mining Sections meet on different Thursdays.

Central Railway Club. Sec.: Harry D. Vought, 62 Liberty St., New York. Regular meetings on second Friday of January, March, May, September, and November, Hotel Iroquois, Buffalo.

Chicago Electrical Association. Sec.: W. B. Hale, Monadnock Building. Regular meetings on first and third Fridays of each month, from October to May.

Civil Engineers' Club of Cleveland. Sec.: Joseph C. Beardsley, 689 The Arcade. Regular meetings on second and fourth Tuesdays of each month.

Civil Engineers' Society of St. Paul. Sec.: G. S. Edmondstone. Regular meetings on second Monday of each month.

Engine Builders' Association of the United States. Sec.: F. P. Ide, Springfield, Ill. Next meeting, May, at Chicago.

Engineering Association of the South. Sec.: Robt. L. Lund, 2102 Hayes St., Nashville, Tenn. Regular meetings on second Thursday of each month at the Berry Block.

Engineers' Club of Chicago. Sec.: B. W. Thurtell, 1223 New York Life Building. Regular meetings on first and third Tuesdays of each month.

Engineers' Club of Cincinnati. Sec.: J. F. Wilson, P. O. Box 333. Regular meeting on third Thursday of each month, except July and August.

Engineers' Club of Columbus (Ohio). Sec.: H. M. Gates, 12½ North High St. Regular meetings on third Saturday of each month.

Engineers' Club of Minneapolis. Sec.: Jas. B. Gilman, American Bridge Co. Regular meetings on third Monday of each month.

Engineers' Club of Philadelphia. Sec.: J. O. Clarke, 1122 Girard St. Regular meetings on first and third Saturdays of each month, except July and August.

Engineers' Club of St. Louis. Sec.: H. J. Pfeifer, 920 Rialto Bldg. Regular meetings on first and third Wednesdays of each month.

Engineers' Society of Western New York. Sec.: H. B. Alverson, 533 Ellicott Square, Buffalo. Regular meetings on first Tuesday of each month.

Engineers' Society of Western Pennsylvania. Sec.: Chas. W. Ridinger, 410 Penn. Ave., Pittsburg. Regular meetings on third Tuesday of each month.

Franklin Institute. Sec.: Dr. Wm. H. Wahl, 15 South 7th St., Philadelphia. General meetings on third Wednesday of each month, except July and August. General section meetings every Thursday.

Honolulu Engineering Association. Sec.: G. F. Bush, Honolulu, Hawaii.

International Electrical Congress. Sec.: Dr. A. E. Kennelly, Harvard University, Cambridge, Mass. Meeting, Sept. 12 to 17, at St. Louis.

International Engineering Congress. Sec.: Charles Warren Hunt, 220 W. 57th St., New York. Meeting Oct. 3 to 8, at St. Louis.

Iowa Railway Club. Sec.: P. B. Vermillion, Des Moines, Iowa. Regular meetings on third Tuesday of each month.

Louisiana Engineering Society. Sec.: G. W. Lawes, 806 Gravier St., New Orleans. Regular meetings on second Monday of each month.

Master Car Builders' Association. Sec.: J. W. Taylor, 667 Rookery, Chicago. Meeting, June 22-24, Saratoga Springs, N. Y.

Montana Society of Engineers. Sec.: Clinton H. Moore, Butte, Mont. Regular meetings on second Saturday in each month.

National Electric Light Association. Sec.: Ernest H. Davis, 136 Liberty St., New York. Annual convention, May 24-27, at Boston.

New England Railroad Club. Sec.: Edw. L. Janes, Back Bay P. O., Boston. Regular meetings, second Tuesday in each month, except June, July, August and September, at Pierce Hall, Copley Square.

New York Electrical Society. Sec.: Geo. H. Guy, 114 Liberty St., New York. Meetings monthly, on different Wednesdays, at the American Institute, 19 W. 44th St.

New York Railroad Club. Sec.: Harry D. Vought, 62 Liberty St., New York. Regular meetings on third Friday of each month, except June, July and August, at Carnegie Hall, 154 W. 57th St., New York.

New York Street Railway Association. Sec.: W. W. Cole, Elmira. Annual meeting, Sept., at Utica.

North-West Railway Club. Sec.: T. W. Flannagan, Minneapolis, Minn. Regular meetings on first Tuesday after second Monday of each month, except June, July and August, alternating between Minneapolis and St. Paul.

Pacific Coast Electrical Transmission Association. Sec.: Geo. P. Low, 237 Cherry St., San Francisco. Annual convention, third Tuesday in June. Intermediate meetings subject to call.

Pacific Coast Railway Club. Sec.: C. C. Borton, West Oakland, Cal. Regular meetings on third Saturday of each month at San Francisco and other cities.

Pacific Northwest Society of Engineers. Sec.: Prof. M. Roberts, Seattle, Wash. Meetings monthly in Chamber of Commerce rooms, Seattle.

Railway Club of Pittsburg. Sec.: J. D. Conway, P. & L. E. R. R., Pittsburg, Pa. Regular meetings on fourth Friday of each month, except June, July and August, at Hotel Henry.

Railway Signal Association. Sec.: B. B. Adams, 83 Fulton St., New York. Regular meetings on second Tuesday of January, March, May, Sept. and Nov.

Richmond Railway Club. Sec.: F. O. Robinson, 8th & Main Sts., Richmond, Va. Regular meetings on second Thursday of each month, except June, July and August.

Roadmasters' and Maintenance of Way Association. Sec.: J. C. Rockhold, Stockton, Cal. Annual meeting, Sept., at St. Louis.

Rocky Mountain Railway Club. Sec.: M. M. Currier, Colorado City. Regular meetings on second Tuesday of each month, at Union Depot, Denver.

St. Louis Railway Club. Sec.: E. A. Chenery, Union Station, St. Louis. Regular meetings on second Friday of each month, except July and August.

Society of Chemical Industry, New York Section. Sec.: H. Schweitzer, 40 Stone St. Meetings on third Friday after the first Monday of each month, at Chemists' Club, 108 W. 55th St.

Southern and Southwestern Railway Club. Sec.: W. A. Love, Atlanta, Ga. Regular meetings on third Thursday of Jan., April, Aug. and Nov., at Atlanta.

Technical Society of the Pacific Coast. Sec.: Otto von Geldern, 31 Post St., San Francisco. Regular meetings on first Friday of each month.

Texas Railway Club. Sec.: T. H. Osborne, Pine Bluff, Ark. Regular meetings on third Monday of April and September.

Toledo Society of Engineers. Sec.: L. M. Gram, 519 Gardner Building, Toledo, O. Meetings on third Friday of each month in National Union Building.

Western Railway Club. Sec.: J. W. Taylor, 667 Rookery, Chicago. Meetings on third Tuesday of each month, except June, July and August, Auditorium Hotel, Chicago.

Western Society of Engineers. Sec.: J. H. Warder, Monadnock Block, Chicago. Regular meetings on first Wednesday and extra meetings on third Wednesday of each month, except July and August.

Personal.

—Mr. William R. Grace, ex-Mayor of New York, and president of the Ingersoll-Sergeant Drill Co., died in the latter part of March.

—Mr. William L. Saunders, who has been vice-president of the Ingersoll-Sergeant Drill Co. since 1897, has succeeded the late Mr. William R. Grace as president.

—Mr. Julian Kennedy has moved his engineering offices to the Bessemer Building, Sixth Street and Duquesne Way, Pittsburg.

—Mr. Hayden Eames, who is the selling agent for the automobile products of the

Federal Manufacturing Company, of Cleveland, has issued a little pamphlet entitled, "Will It Pay You to Change to Electric Wagons?" which contains some excellent advice for those who are contemplating a change from horse-drawn to electric vehicles.

—Mr. O. S. Kelly, president of the Kelly-Springfield Road Roller Co., of Springfield, Ohio, died recently at the age of eighty-two years.

—Mr. Rodney Strong Dennis, of the firm of Patterson, Teele and Dennis, of 30 Broad St., New York, died in March.

—Mr. Robert L. Warner has been relieved of the detail duties of management of the Boston office of the Westinghouse Electric Mfg. Company and appointed their New England manager. Mr. Warner will have general charge of their business in New England, and will be assisted by Mr. D. E. Manson, who is appointed manager of the Boston office.

—Mr. M. Greenwood, formerly Pittsburg manager of the International Steam Pump Co., has been engaged by Fairbanks, Morse & Company, of Chicago, to look after their steam pump business in Pittsburg territory.

—Mr. C. C. Starr, who was formerly connected with the firm of John Starr, Son & Company, has been engaged by the Canadian Westinghouse Company, Limited, of Hamilton, Canada, to act as their representative in the Maritime Provinces, with headquarters at 134 Granville Street, Halifax, Nova Scotia. The Maritime Provinces are included in the district of the Canadian Westinghouse Company's Montreal office, and Mr. Starr will be consequently an attaché of that office.

—Ernst J. Lederle, Ph. D., announces that he has established laboratories for sanitary, chemical and bacteriological investigations, at 518 Fifth Avenue, New York. Especial attention will be given to general building sanitation; supervision of public and private water supplies; drainage and sewage disposal systems; chemical and bacteriological analyses of water, milk, foods and commercial products; clinical investigations for physicians; and toxicological examinations.

—Mr. George J. Bancroft, Jr., well known throughout the West by his professional work as consulting engineer to the Stratton estate, as well as in other enterprises, has become associated with the Engineering Company of America and will take charge of their department of Mine Management. His headquarters will be in Denver.

—Mr. G. P. Altenberg, manager of the Foreign Department of J. A. Fay & Egan Co., the manufacturers of woodworking machinery, is on a trip, of several months' duration, through Europe.

Industrial Notes.

—On March 31 a contract for 37,000 square yards of the Bitulithic pavement was awarded by the city council of Shreveport, La., to the Nashville Roofing and Paving Company. Prior to the awarding of this contract a committee, consisting of the mayor, city engineer and other officials of the city of Shreveport, made an extended tour of investigation of the Bitulithic pavement, and in consequence of their unanimous approval an additional award of 10,000 square yards was made at a special meeting of the Shreveport city council held Monday evening, April 4. This pavement is controlled by the Warren Brothers Company, of New York and Boston.

—The Havana Construction Company, engineers and contractors of Havana, Cuba, have closed a contract for the installation of the electric light plant of the city of Guanabacoa, Cuba.

—The Pelton Water Wheel Company, after some early struggles with hydraulic problems in the introduction of their impulse wheels, have built up a business which they can regard with just pride. There are now running something more than 11,000 Pelton wheels in various parts of the world, developing altogether over 1,000,000 horse-power for electric transmission, mining, manufacturing and other purposes. In the United States alone there are about 8,800 of these wheels, with an aggregate of 811,035 horse-power, and in other countries are 2,240 wheels, totaling 278,405 horse-power.

—The Crocker-Wheeler Company, the manufacturers and electrical engineers, of Ampere, N. J., has doubled its capital stock, which has been $1,000,000. This company, which is the largest of the independent electrical manufacturers, was organized in 1892 by Dr. Schuyler Skaats Wheeler and Prof.

Francis B. Crocker, on a relatively modest basis. It now has fifteen branch offices from Boston to San Francisco, and does one of the largest businesses in the world in electric power apparatus. The capitalization was several times increased, until in 1899 it had become $1,000,000. In view of the rapidly expanding business the stockholders have now decided to increase this amount to $2,000,000.

The Lozier Motor Co., the builders of motor boats, whose offices are at 1 Broadway, New York, and whose works are at Plattsburg and Westchester, N. Y., issue an attractive and entertaining monthly publication, called *The Propeller,* the April number of which contains a project for a motor-boat trip from New York to the St. Louis Fair, views af a Lozier boat in the harbor of San Juan, Porto Rico, and pictures of recent Lozier exhibits at London, Paris and New York, and has many other interesting features.

—Wyman & Gordon, of Worcester, Mass., the manufacturers of drop forgings, have issued a short sketch of the life of Thomas Newcomen, by Dwight Goddard, as the latest number of their interesting series of brief biographies of engineers.

—The American Blower Company, of Detroit, are at present installing their "A B C" fan system of heating in the new shops of the Olds Gasoline Engine Works, at Lansing, Mich., which contract they secured because of the excellence of the lay-out submitted to the engineers of the buildings, Field, Hinchman & Smith, of Detroit.

—F. L. Smidth & Co., Engineers, have moved from William Street and Maiden Lane to the J. Monroe Taylor Building, 39-41 Cortlandt Street, New York.

—The Northern Electrical Mfg. Co., of Madison, Wis., will have an extensive exhibit in Section 14 of the Palace of Electricity at the St. Louis World's Fair.

—Beaudry & Company, of Boston, Mass., the builders of the Beaudry champion power hammer and the Beaudry duplex forging press, have moved their offices to the new Oliver Building, 141 Milk Street.

—A. Leschen & Sons Rope Co., of St. Louis, the manufacturers of wire rope and aerial tramways, have brought out a wire-rope gauge for diameters ranging from 1/4 inch to 1 1/4 inches. This rope gauge or caliper is of celluloid and of a size which makes it convenient to carry in a vest pocket. It will undoubtedly prove useful to anyone who uses or handles wire rope, and will be sent to inquirers on application.

—The Nernst Lamp Company has recently removed its Boston office from 131 State Street to 501 Atlantic Avenue. The office will as heretofore be in charge of Mr. George C. Ewing as district manager, and will carry a complete stock of Nernst lamps and supplies, insuring prompt service to customers.

—The Chicago Pneumatic Tool Company have begun the publication of a monthly magazine devoted to the interests of pneumatic appliances and their motive power, at their general offices in the Fisher Building, Chicago. The initial number of this journal, which bears the name of *Something Pneumatic,* contains illustrated articles on the Redfield pneumatic saw, on the use of the pneumatic hammer in chipping, calking, riveting, stone working and mining, on the modern torpedo, and on other subjects, and various interesting items about compressed air and pneumatic appliances.

—The Tabor Manufacturing Co., of Philadelphia, makers of foundry molding machines, revolution counters and other engineering appliances, have opened an office at Boston, in the Mason Building, 70 Kilby Street, in charge of Mr. C. S. Lovell.

—The Cancos Manufacturing Co., of Philadelphia, the manufacturers of steam and hydraulic packings of every description, have prepared a convenient little memorandum book for engineers, which they send with trial orders of their Black Squadron ring packing. This book contains miniature maps of the United States and its island possessions, Canada, Mexico and South America, populations of cities in the United States, calendar, postal regulations, weather bureau signals, mensuration and other mathematical rules, weights and measures, data about coal, and other useful information, besides square-ruled pages for notes and memoranda.

—The Allis-Chalmers Company announce that in connection with the great extension of their business by becoming builders of gas engines, steam turbines, hydraulic machinery and electrical machinery, in addition to the classes of output for which their several works have been for many years renowned—*i. e.*, reciprocating steam engines, pumping engines, rolling-mill engines, blowing engines, mining machinery, flour-mill machinery, saw-mill machinery, rock-crushing machinery, cement machinery, perforated metals, etc., etc., they have organized a Department of Publicity, of which Mr. Arthur Warren, who is well known in this field, has been appointed manager. They request that all communications referring to publicity in any form connected with the Allis-Chalmers Company, including the Bullock Electric Manufacturing Co., which they have acquired, will be for the future addressed to The Department of Publicity, Allis-Chalmers Company, Milwaukee, Wis.

—The New Jersey Foundry & Machine Co., of 9-15 Murray Street, New York, have issued a collection of facsimile letters from the principal manufacturers of coach screws and lag screws, in which these manufacturers say that they have agreed to use a standard thread which shall fit the Diamond expansion shield made by the above company. These standard threads are 5-16-inch diameter, 9 threads per inch; ⅜-inch diameter, 7 per inch; ½-inch, 6 per inch; ⅝-inch, 5 per inch; ¾-inch, 4½ per inch.

—The Maxfield-Francke Co. have removed their offices from 120 Liberty Street to the Electrical Exchange Building at 136 Liberty Street, New York, where they will be glad to give prompt attention to inquiries concerning the Francke four-ported steam engine and their other specialties.

—The New York Agency of the Grand Trunk Railway System are now occupying what is one of the handsomest railroad offices in the world, on the ground floor of the new Dun Mercantile Agency Building, at 290 Broadway, New York. The floor is finished throughout in Sienna marble, bronze and plate glass, these decorations costing the owners of the building $100,000, and it is considered the finest display of this handsome stone in America. The Grand Trunk leased the entire floor and called it the "Railway Exchange," having as subtenants: Great Eastern Fast Freight Line, Lehigh Valley Railroad Co., Maine Steamship Co., Clyde Steamship Co., Queen & Crescent Route, Louisville & Nashville Railroad Co., Wisconsin Central Railroad Co., Central Railroad of New Jersey, The Central States Dispatch, Pere Marquette Railroad Co., Georgia Railroad Co. The consolidation of these interests is a new departure, and in the brief time that they have been together it has operated to so much advantage to the roads interested, and has been such an accommodation to the shipping and traveling public that its success is assured.

—The Philadelphia office of the B. F. Sturtevant Company has just placed an order for fifty of "The Reeves" variable-speed transmissions, with the manufacturers, the Reeves Pulley Company, of Columbus, Ind. The order was placed through the Philadelphia agent of the Reeves Pulley Company, Mr. W. R. Shipley. The Sturtevant Company are using "The Reeves" transmission on their rotary cement kilns and coal conveyers.

—The John Davis Company since January 1st, 1904, have installed the following large sizes of the Hochfeldt Eclipse back-pressure valves, and each and every one is giving the very best satisfaction: four 14-inch, two 20-inch, four 12-inch, two 16-inch, one 24-inch, one 30-inch, two 10-inch.

—The F. W. Braun Co., of Los Angeles, Cal., propose to have a very complete and interesting exhibit of goods of their manufacture at the St. Louis Exposition this summer, including all of their patented labor-saving devices for laboratory use, such as crushers, pulverizers, crucible and muffle furnaces, bullion-melting furnaces, laboratory cyanide plants, gasoline, crude oil and illuminating gas burners, blowpipe outfits, etc. Their display will be located near the southwest corner of the Mines and Metallurgy Building.

—The Patterson Tool & Supply Co., of Dayton, O., have brought out a folding circular which gives a very good representation of a case filled with drawing instruments.

—Advertising managers representing various prominent manufacturies in Cleveland recently formed an organization for mutual benefit, to be known as the Manufacturers' Advertising Club. Meetings will be held monthly, and at each meeting an address will be delivered by an advertising expert. At the meeting on April 12th, Mr. Boyd, of The Curtis Publishing Co., was the speaker. The officers of the club are: President, Mr. Charles B. Shanks, of The Winton Motor

Carriage Co.; vice-president, Mr. William Townsley, Jr., of The Grasselli Chemical Co.; secretary, Mrs. F. A. McIntosh, of The Standard Tool Co.; treasurer, Miss E. L. Harmon, of The Loew Supply & Mfg. Co. The membership of the club excludes advertising solicitors and brokers.

—The fourth annual sessions of the Summer School for Artisans, held under the direction of the College of Engineering of the University of Wisconsin, begins June 27th, and continues for a period of six weeks. Courses of study are offered in the following subjects: 1. Steam, gas and other heat engines: Lectures on the theory of heat, the operation and methods of testing steam, gas and air engines, boilers, compressed air and refrigeration plants. 2. Applied electricity: Theory of direct and alternating current dynamos and motors, the operation and methods of testing electrical machinery, batteries, transformers and other apparatus, photometry, and calibration of instruments. 3. Mechanical drawing and machine design: Elements of applied mathematics, courses in mechanical drawing and machine design adapted to the preparation of the students. 4. Materials of construction, fuels and lubricants: Lectures on the properties of materials, accompanied by laboratory tests; lectures on fuels and lubricants with laboratory tests on the heating value of coals and efficiency of lubricants. 5. Shop work: Practice with hand tools, wood and metal-working machinery, and in blacksmithing and pattern making. The instructional force is taken from the regular faculty of the College of Engineering, and the entire laboratory and shop equipment belonging to the college is used by the students in the Summer School. The requirements for admission do not extend beyond a working knowledge of English and arithmetic, but the policy is to allow a large amount of individual work so that the student may take advantage of all the preparation he has obtained. As the demand renders it necessary, advanced courses will be established in the various subjects. This school offers to those unable to take a regular four-year course, an opportunity of obtaining practical working knowledge of the methods of testing and the use of instruments, together with such theoretical principles in each case as the nature of the subject and preparation of the student may permit. A bulletin describing the work of the School for Artisans in detail will be sent on application to Frederick E. Turneaure, Dean College of Engineering, Madison, Wis.

—In the beginning of 1901 the Society of German Engineers (Verein Deutscher Ingenieure) began the compilation of a universal technical dictionary, called the "Technolexikon," in the three languages: English, German, and French. This undertaking has met with general approval and has received assistance from all quarters at home and abroad. Societies and individuals have responded generously to the invitation to collaborate and have proved their interest by the transmission of collections of technical words made by them, or by promising such in the near future. Up to the present, there are 363 societies (51 in English, 274 in German and 38 in French speaking countries) co-operating in the work, either by the systematic collection of technical expressions of the specialties represented by them, or in other ways, especially by the acquisition of collaborators and by placing technical publications in more than one language at the disposal of the "Verein," such as catalogues of firms, inventories, piece-lists of machines, handbooks, &c. For convenience sake the Society of German Engineers has provided handy note-books for the collaborators to write their collections in and so far 317 filled-out note-books have been forwarded voluntarily to the office at the address given below. Contributions from all technical branches (including the handicrafts) are welcome, and it is obvious that small contributions from a host of various collaborators will be more useful than large ones compiled by a few men, who naturally cannot cover so many specialties. Attention is to be drawn to the fact that contributions in only one language are also acceptable. The note-books are now being called in, but important contributions may be made use of in exceptional cases if they are received before printing begins, which will be about June, 1906. The editor-in-chief will be pleased to give any information wanted. Address: Technolexicon, Dr. Hubert Jansen, Berlin (N W. 7), Dorotheenstr, 40.

NEW CATALOGUES AND TRADE PUBLICATIONS

These catalogues may be had free of charge on application to the firms issuing them. Please mention The Engineering Magazine when you write.

Alternators.

Catalogue No. 60, containing descriptions, half-tone illustrations, diagrams and tables of data of alternating-current generators with revolving fields and stationary armatures, and other alternating-current machinery for lighting, power and railway service. 9 by 6 in.; pp. 40. National Electric Company, Milwaukee.

Air Engine.

Pamphlet containing a reprint of an article from *The Iron Age,* which gives an illustrated description of the Pilling air engine, built on the lines of the oscillating steam engine, and its application to hoisting and other purposes. 8 by 6 in.; pp. 8. Pilling Engine Works, Bucyrus, Ohio.

Ball Bearings.

Booklet with illustrations and description of the American compound bearing, or Chapman double-ball bearing, for automobiles, bicycles and vehicles of every description, shafting, engines and all kinds of machines. 3½ by 6 in.; pp. 4. Also, facsimile testimonials from users of these bearings, showing their great efficacy in reducing friction to a minimum. American Compound Bearing Co., 25 Broad St., New York.

Blowers.

Catalogue No. 30, with illustrations and descriptions of volume blowers and exhausters for all purposes, which are adjustable, reversible and interchangeable, and may be placed on either the floor, the ceiling or the wall. 9 by 6 in.; pp. 16. The Indiana Fan Company, Indianapolis.

Blue-Printing Machines.

Catalogue, containing description and illustrations of the Federal blue-printing machine, which employs a transparent apron, can be run at any speed desired, takes any size print, permits prints and tracings to be easily fed to it, and may be used with either sunlight or electric light. 9 by 6 in.; pp. 12. Spaulding Print Paper Co., Inc., Boston.

Card Systems.

Catalogue, with illustrations, descriptions and prices of index cards, guide cards, pocket card-index outfit, card cabinets, card boxes, vertical-file folders, cases and cabinets, sectional cabinets and bookcases, desk portfolio, transfer cases, desks, chairs, and all kinds of index and filing devices. 10 by 7 in.; pp. 22. Koller & Smith, Port Richmond, N. Y.

Castings.

Booklet, folder and card devoted to Franklin finished castings, which are die-cast in steel molds, and are then completely ready for assembling in a machine. These castings comprise gears and all kinds of small parts, of any degree of complication. 6 by 3½ in.; pp. 12. H. H. Franklin Mfg. Co., Syracuse, N. Y.

Condensers.

Catalogue D, containing illustrated descriptions of twin vertical air pumps and condensers, guaranteed to produce the highest vacuum by mechanical means, for marine and stationary steam engines and for salt, sugar and chemical works. 6 by 3½ in.; pp. 12. Great Lakes Engineering Works, Detroit.

Crushers.

Large catalogue, with illustrated descriptions of gyratory crushers, of great capacity and economical operation, for rock, ore and similar materials, screens, dump cars, dump carts and stone-spreading wagons, and plans and views of crushing plants. 7½ by 10¾ in.; pp. 84. Austin Mfg. Co., Chicago.

Electric Heating.

Catalogue, with descriptions and illustrations of electric cooking utensils, glue pots, soldering irons, instrument sterilizers, radiators, laundry apparatus, and many other electric heating appliances, for use on shore and on shipboard. 8 by 5 in.; pp. 82. Simplex Electric Heating Company, Cambridge, Mass.

Electric Machines.

Bulletin No. 148, illustrating and describing a new line, termed type "S," of direct-current dynamos and motors, both open and enclosed, and in floor, ceiling, wall and vertical styles, with their details and tables of dimensions. 10 by 7½ in.; pp. 12. The C & C Electric Co., 143 Liberty St., New York.

Electric Motors.

Circulars Nos. 1077 and 1078, devoted, respectively, to direct-current, series-wound motors for cranes, hoists and other intermittent service requiring a large starting torque, and to single-phase alternating-current railway motors and car equipment, with illustrations and diagrams. 10 by 7 in.; pp. 20 and 12. Westinghouse Electric & Manufacturing Co., Pittsburg.

Bulletins Nos. 1002 A and 1023, devoted, respectively, to Type "N" direct-current, multipolar motors, especially designed for direct connection to machine tools, and to Type "B" direct-current motors, constructed to withstand rough usage, with illustrations of motors and their parts, and motor-driven machines and tools, diagrams and dimension tables. 9 by 6 in.; pp. 28 and 12. Bullock Electric Mfg. Co., Cincinnati.

Bulletin No. 35, containing profusely illustrated descriptions of multipolar direct-current electric motors and their details, in many different styles, for driving tools and machinery of all kinds. 10 by 6¾ in.; pp. 36. Also, leaflets devoted to generators in lighting service, and motors operating Coffin hydraulic sluice valves, emery grinders and machine tools. Northern Electrical Manufacturing Co., Madison, Wis.

Electric Supplies.

Perpetual catalogue, made up in bulletin form, containing illustrations and descriptions of electric pole-line materials, arc-light mast arms and pulleys, switches, circuit breakers, fuses, lightning arresters, transformers, arc and incandescent lamps, brackets, electroliers, rheostats and controllers, telephone booths, primary batteries, and a great variety of other electrical supplies and machinery. 10 by 7½ in. The F. Bissell Company, Toledo, O.

Expanding Tools.

Catalogue, containing descriptions and illustrations of the Lovekin new and efficient tools and machinery for expanding and flanging iron, steel and copper pipe of all sizes, and for expanding valve seats in gate, globe and angle valves. 9 by 6 in.; pp. 36. Also stock list of a great variety of tools and appliances and iron and steel supplies. 7 by 4½ in.; pp. 144. Scully Steel & Iron Co., Chicago.

Expansion Bolts.

Price list and illustrated descriptions of Church's patent expansion bolts for fastening all kinds of structure to brick, stone and cement work, expansion awning and shutter hinges, expansion screw eyes, anchor and toggle bolts, and other fastenings. 6 by 3¼ in.; pp. 12. Isaac Church, Toledo, Ohio.

Fireproof Construction.

Large pamphlet on the fires at Baltimore and in the Iroquois Theatre, Chicago, containing a description of the effects of the fire upon various materials employed in modern fireproof buildings, with remarks on the lessons of the fires and recommendations for future construction, and with many handsome illustrations. 9 by 10 in.; pp. 62. The Roebling Construction Company, Broadway and 23rd St., New York.

Lubricators.

Catalogue No. 9, containing illustrations, descriptions and prices of sight-feed lubricators, glass and brass oil cups, oil pumps, grease cups, water gauges, gauge cocks, throttle valves, dynamo and motor oil gauges, boiler oil feeders, and other devices for lubricating cylinders, bearings and engines. 10¼ by 7¾ in.; pp. 108. Michigan Lubricator Co., Detroit.

Machine Tools.

Very large and comprehensive cloth-bound catalogue, profusely illustrated with half tones, and containing views of the various works of the Niles-Bement-Pond Company, reproductions of medals and diplomas awarded them, and descriptions of lathes, planers, boring and turning mills, boiler-shop machinery, hydraulic presses and riveters, steam hammers, electric traveling cranes, small tools, and many other kinds of machine tools. Metric as well as English dimensions are given, and there is a complete index. 12 by 9 in.; pp. 713. Niles-Bement-Pond Co., 136-138 Liberty St., New York.

Oil Separator.

Catalogue No. 14, describing and illustrating the Austin "special" oil separator for extracting oil from exhaust steam, operating under a vacuum, or otherwise, and delivering pure, distilled water of condensation, and particularly adapted to large steam plants. 8 by 5¾ in.; pp. 12. Austin Separator Co., Detroit.

Pneumatic Hoists.

Catalogue, containing descriptions, illustrations and prices of pneumatic motor hoists, cylinder air hoists, trolleys, winding drums, foundry elevators, car jacks, jib cranes and other pneumatic hoisting machinery. 9 by 6 in.; pp. 32. Chicago Pneumatic Tool Co., Chicago.

Shapers.

Catalogue C, containing half-tone illustrations and descriptions of various styles of crank shapers, rack shapers, and traverse shapers, the latter with single and double heads and with swivelling saddle, designed for machining both ends of a steel beam at one time. These shapers are either belt driven or connected to electric motors, and embody many special features with all the latest improvements. 6 by 9 in.; pp. 45. The Cincinnati Shaper Co., Cincinnati.

Silicate Stone.

Pamphlet, containing descriptions and illustrations of Ford's patent silicate-of-lime building stone, in very large or small blocks, bricks, tiles and paving slabs, with results of highly satisfactory compressive, tensile, weathering and chemical tests. 11 by 8 in.; pp. 8. Silicate Stone Co., 39 Wall St., New York.

Steam Engines.

Catalogue No. 55, containing half-tone illustrations and descriptions of Corliss engines, simple and compound, belted and direct-connected, with girder, Tangye and rolling-mill type frames, and of air compressors, fire-tube and water-tube boilers, feed-water heaters and complete power plants. 7 by 9 in.; pp. 62. Murray Iron Works Co., Burlington, Iowa.

Steam Receivers.

Booklet describing and illustrating the Simonds improved steam receiver and separator for storing the steam near the cylinder and separating the entrained water and foreign substances from the steam, and containing an interesting discussion of some points that are often overlooked in designing steam plants. 6 by 3½ in.; pp. 16. Frank A. Simonds, Grand Rapids, Mich.

Thermometers.

Illustrated pamphlet, giving an account of the making of thermometers, and describing a thermometer, or thermo steam gauge, and pocket for process kettles used in the canning industry. 7 by 5½ in.; pp. 10. The Hohmann & Maurer Mfg. Co., Rochester, N. Y.

Wire Rope Tramways.

Catalogue, containing descriptions and illustrations of automatic aerial wire-rope tramways on the double-rope, single-rope, two-bucket, one-bucket, excavator and special systems, for mining work, lumbering and other purposes, hoisting and conveying cableways for logging, quarrying, coal handling, placer mining and construction work, and incline railways. 9 by 6 in.; pp. 34. Hallidie-Painter Tramway Co., San Francisco.

NEWS SUPPLEMENT

The Engineering Magazine—June, 1904

Coming Society Meetings.

American Boiler Manufacturers' Association. Sec.: J. D. Farasey, Cleveland. Next meeting, Oct. 4-6, St. Louis.

American Foundrymen's Association. Sec.: Dr. Richard Moldenke, P. O. Box 432, New York. Convention June 7-9, at Indianapolis, and June 10, at St. Louis.

American Institute of Electrical Engineers. Sec.: Ralph W. Pope, 95 Liberty St., New York. Convention, Sept. 12-17, St. Louis.

American Institute, Polytechnic Section. Sec.: George Whitefield, Jr., 19 W. 44th St., New York. Meetings on first and third Thursdays of each month, from October to May, inclusive.

American Park and Outdoor Art Association. Sec.: C. M. Robinson, Rochester, N. Y. Annual meeting, June 9-11, at St. Louis.

American Railway Master Mechanics' Association. Sec.: J. W. Taylor, 667 Rookery, Chicago. Meeting, June 27-29, Saratoga Springs, N. Y.

American Railway Mechanical and Electrical Association. Sec.: Walter Mower, Detroit. Annual meeting, Oct. 10-15, at St. Louis.

American Society for Testing Materials. Sec.: Prof. Edgar Marburg, University of Pennsylvania. Annual meeting, June 16-18, at Atlantic City, N. J.

American Society of Civil Engineers. Sec.: C. W. Hunt, 220 W. 57th St., New York. Regular meetings, first and third Wednesdays of each month, except July and August.

American Society of Mechanical Engineers. Sec.: Prof. F. R. Hutton, 12 W. 31st St., New York. Joint meeting with the Institution of Mechanical Engineers of Great Britain, May 31 to June 3, at Chicago.

American Street Railway Association. Sec.: T. C. Penington, 2020 State St., Chicago. Annual meeting, Oct. 10-15, at St. Louis.

American Water-Works Association. Sec.: J. M. Diven, Elmira, N. Y. Annual convention, June 6 to 10, at St. Louis.

Boston Society of Civil Engineers. Sec.: S. E. Tinkham, 715 Tremont Temple, Regular meetings on third Wednesday of each month, except July and August.

Brooklyn Engineers' Club. Sec.: J. Strachan, 191 Montague St. Regular meetings on second Thursday of each month.

Canadian Electrical Association. Sec.: C. H. Mortimer, Toronto, Ont. Annual convention, June 15-17, at Hamilton, Ont.

Canadian Railway Club. Sec.: W. H. Rosevear, Jr., Montreal. Regular meetings on first Tuesday of each month, except June, July and August.

Canadian Society of Civil Engineers. Sec.: Prof. C. H. McLeod, 877 Dorchester St., Montreal. The General Section and the Electrical, Mechanical and Mining Sections meet on different Thursdays, from October to May.

Central Railway Club. Sec.: Harry D. Vought, 62 Liberty St., New York. Regular meetings on second Friday of January, March, May, September and November, Hotel Iroquois, Buffalo.

Chicago Electrical Association. Sec.: W. B. Hale, Monadnock building. Regular meetings on first and third Fridays of each month, from October to May.

Civil Engineers' Club of Cleveland. Sec.: Joseph C. Beardsley, 689 The Arcade. Regular meetings on second and fourth Tuesdays of each month.

Civil Engineers' Society of St. Paul. Sec.: G. S. Edmondstone. Regular meetings on second Monday of each month.

Engineering Association of the South. Sec.: Robt. L. Lund, 2102 Hayes St., Nashville, Tenn. Regular meetings on second Thursday of each month at the Berry block. Convention at St. Louis.

Engineers' Club of Chicago. Sec.: B. W. Thurtell, 1223 New York Life building. Regular meetings on first and third Tuesdays of each month.

Engineers' Club of Cincinnati. Sec.: J. F. Wilson, P. O. Box 333. Regular meeting on third Thursday of each month, except July and August.

Engineers' Club of Columbus (Ohio). Sec.: H. M. Gates, 5½ West Broad St. Regular meetings on third Saturday of April, May, June and September.

Engineers' Club of Minneapolis. Sec.: Jas. B. Gilman, American Bridge Co. Regular meetings on third Monday of each month, except July and August.

Engineers' Club of Philadelphia. Sec.: J. O. Clarke, 1122 Girard St. Regular meetings on first and third Saturdays of each month, except July and August.

Engineers' Club of St. Louis. Sec.: H. J. Pfeifer, 920 Rialto Bldg. Regular meetings on first and third Wednesdays.

Engineers' Society of Western New York. Sec.: H. B. Alverson, 533 Ellicott Square, Buffalo. Regular meetings on first Tuesday of each month.

Engineers' Society of Western Pennsylvania. Sec.: Chas. W. Ridinger, 410 Penn Ave., Pittsburg. Regular meetings on third Tuesday of each month.

FRANKLIN INSTITUTE. Sec.: Dr. Wm. H. Wahl, 15 South 7th St., Philadelphia. General meetings on third Wednesday of each month, except July and August. General section meetings every Thursday.

HONOLULU ENGINEERING ASSOCIATION. Sec.: G. F. Bush, Honolulu, Hawaii.

INTERNATIONAL ASSOCIATION OF MUNICIPAL ELECTRICIANS. Sec.: Frank P. Foster, Corning, N. Y. Meeting, Sept. 13-14, at St. Louis.

INTERNATIONAL ELECTRICAL CONGRESS. Sec.: Dr. A. E. Kennelly, Harvard University, Cambridge, Mass. Meeting, Sept. 12 to 17, at St. Louis.

INTERNATIONAL ENGINEERING CONGRESS. Sec.: Charles Warren Hunt, 220 W. 57th St., New York. Meeting, Oct. 3 to 8, at St. Louis.

IOWA RAILWAY CLUB. Sec.: P. B. Vermillion, Des Moines, Iowa. Regular meetings on third Tuesday of each month.

LOUISIANA ENGINEERING SOCIETY. Sec.: G. W. Lawes, 806 Gravier St., New Orleans. Regular meetings on second Monday of each month.

MASTER CAR BUILDERS' ASSOCIATION. Sec.: J. W. Taylor, 667 Rookery, Chicago. Meeting, June 22-24, Saratoga Springs, N. Y.

MONTANA SOCIETY OF ENGINEERS. Sec.: Clinton H. Moore, Butte, Mont. Regular meetings on second Saturday in each month.

NATIONAL ELECTRICAL CONTRACTORS' ASSOCIATION OF THE UNITED STATES. Sec.: W. H. Morton, Utica, N. Y. Annual convention, Sept. 14-16, at St. Louis.

NATIONAL ELECTRIC LIGHT ASSOCIATION. Sec.: Ernest H. Davis, 136 Liberty St., New York. Meeting, Sept., at St. Louis.

NEW ENGLAND RAILROAD CLUB. Sec.: Edw. L. Janes, Back Bay P. O., Boston. Regular meetings, second Tuesday in each month, except June, July, August and September, at Pierce Hall, Copley Square.

NEW YORK ELECTRICAL SOCIETY. Sec.: Geo. H. Guy, 114 Liberty St., New York. Meetings monthly, on different Wednesdays, at the American Institute, 19 W. 44th St.

NEW YORK RAILROAD CLUB. Sec.: Harry D. Vought, 62 Liberty St., New York. Regular meetings on third Friday of each month, except June, July and August, at Carnegie Hall, 154 W. 57th St., New York.

NEW YORK STREET RAILWAY ASSOCIATION. Sec.: W. W. Cole, Elmira. Annual meeting, Sept., at Utica.

NORTHWESTERN ELECTRICAL ASSOCIATION. Sec.: Thos. R. Mercein, Milwaukee. Annual convention, Sept., at St. Louis.

NORTH-WEST RAILWAY CLUB. Sec.: T. W. Flannagan, Minneapolis, Minn. Regular meetings on first Tuesday after second Monday of each month, except June, July and August, alternating between Minneapolis and St. Paul.

PACIFIC COAST ELECTRICAL TRANSMISSION ASSOCIATION. Sec.: Geo. P. Low, 237 Cherry St., San Francisco. Annual convention, third Tuesday in June. Intermediate meetings subject to call.

PACIFIC COAST RAILWAY CLUB. Sec.: C. C. Borton, West Oakland, Cal. Regular meetings on third Saturday of each month at San Francisco and other cities.

PACIFIC NORTHWEST SOCIETY OF ENGINEERS. Sec.: Prof. M. Roberts, Seattle, Wash. Meetings monthly in Chamber of Commerce rooms, Seattle.

RAILWAY CLUB OF PITTSBURG. Sec.: J. D. Conway, P. & L. E. R. R., Pittsburg, Pa. Regular meetings on fourth Friday of each month, except June, July and August, at Hotel Henry.

RAILWAY SIGNAL ASSOCIATION. Sec.: B. B. Adams, 83 Fulton St., New York. Regular meetings on second Tuesday of January, March, May, Sept. and Nov.

RAILWAY WATER SUPPLY ASSOCIATION. Sec.: F. W. Hayden, Glencoe, Minn. Meetings on first Sunday of each quarter at Alexander Hall, South Minneapolis, Minn.

RICHMOND RAILWAY CLUB. Sec.: F. O. Robinson, 8th & Main Sts., Richmond, Va. Regular meetings on second Thursday of each month, except June, July and August.

ROADMASTERS' AND MAINTENANCE OF WAY ASSOCIATION. Sec.: J. C. Rockhold, Stockton, Cal. Annual meeting, Sept., at St. Louis.

ROCKY MOUNTAIN RAILWAY CLUB. Sec.: M. M. Currier, Colorado City. Regular meetings on second Tuesday of each month, at Union Depot, Denver.

ST. LOUIS RAILWAY CLUB. Sec.: E. A. Chenery, Union Station, St. Louis. Regular meetings on second Friday of each month, except July and August.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION. Sec.: C. A. Waldo, Purdue University, Lafayette, Ind. Annual convention, Sept. 1-3, at St. Louis.

SOCIETY OF CHEMICAL INDUSTRY, NEW YORK SECTION. Sec.: H. Schweitzer, 40 Stone St. Meetings on third Friday after the first Monday of each month, except June, July, August and September, at Chemists' Club, 108 W. 55th St.

SOUTHERN AND SOUTHWESTERN RAILWAY CLUB. Sec.: W. A. Love, Atlanta, Ga. Regular meetings on third Thursday of Jan., April, Aug. and Nov., at Atlanta.

TECHNICAL SOCIETY OF THE PACIFIC COAST. Sec.: Otto von Geldern, 31 Post St., San Francisco. Regular meetings on first Friday of each month.

TEXAS RAILWAY CLUB. Sec.: T. H. Osborne, Pine Bluff, Ark. Regular meetings on third Monday of April and September.

TOLEDO SOCIETY OF ENGINEERS. Sec.: L. M. Gram, 519 Gardner Building, Toledo, O. Meetings on third Friday of each month in National Union Building.

TRAVELING ENGINEERS' ASSOCIATION. Sec.: W. O. Thompson, Oswego, N. Y. Next meeting, Sept. 13th, at Chicago.

WESTERN RAILWAY CLUB. Sec.: J. W. Taylor, 667 Rookery, Chicago. Meetings on third Tuesday of each month, except June, July and August, Auditorium Hotel, Chicago.

WESTERN SOCIETY OF ENGINEERS. Sec.: J. H. Warder, Monadnock Block, Chicago, Regular meetings on first Wednesday and extra meetings on third Wednesday of each month, except July and August.

Personal.

—Mr. John Bogart, consulting engineer, has moved his offices from 40 Wall Street to 16 and 18 Exchange Place, New York.

—Mr. H. V. Croll, who has been in charge of the Salt Lake City office of the Allis-Chalmers Company for several years, and who was before that the representative of the E. P. Allis Company at Spokane, has been given charge of the Allis-Chalmers office at San Francisco in the Hayward building as the successor of Mr. George Ames, who has resigned.

—Mr. R. V. Norris has resigned as chief engineer of Coal and Water Companies of the Pennsylvania Railroad Company, with which he has been connected for the past eighteen years, and by which companies he has been retained as consulting engineer, and has opened offices at 99 John Street, New York, and in Wilkes-Barre, Pa. He will give particular attention to the examination of coal properties; the construction, mechanical equipment and modernization of mines and power plants; the design of handling and storage plants for coal and ores; the design of coal breakers and mining machinery and of waterworks and power plants.

—Mr. Irving A. Taylor, who has for many years been connected with the electrical industry, both on the manufacturing side and as consulting engineer, associated with A. B. Herrick, has joined the staff of the Engineering Company of America.

—Messrs. Charles Henry Davis and partners, of 25 Broad Street, New York, have dissolved their firm. Messrs. Davis and Nat Tyler, Jr., have formed a copartnership under the name of Charles Henry Davis & Company, with the same address. Mr. John S. Griggs, Jr., will continue the practice of consulting engineering, also at the above address, and Mr. Timothy W. Sprague has his consulting engineering office at 4 State Street, Boston.

—Mr. James L. Teller, for thirty-four years prominently identified with the Fishkill Landing Machine Co., Fishkill-on-the-Hudson, N. Y., as secretary and treasurer, died recently at his home in Newburgh.

—Mr. James D. Smith, the secretary and treasurer of the J. D. Smith Foundry Supply Co., of Cleveland, died recently.

—Mr. John Reilly, president of the United States Metallic Packing Company and of the Millwood Coal & Coke Company, and vice-president and treasurer of the American Locomotive Sander Company, died recently at his home in Philadelphia.

Industrial Notes.

—THE ENGINEERING MAGAZINE has moved its offices to the Nassau-Beekman Building, 140-142 Nassau Street, corner of Beekman Street, New York, where it will occupy suite 1411 to 1417. Its new telephone number is 5520 John.

—The three engineering societies who are to occupy the Union Engineering building have appointed members to serve on a Joint Library Committee, which has taken up the work of unifying and harmonizing the methods of their several libraries, in order that they may be so administered as to best promote their usefulness to all the societies and to the engineering profession at large. The following gentlemen constitute this committee: For the American Society of Mechanical Engineers: Ambrose Swasey, Henry R. Towne and H. H. Suplee; for the American Institute of Mining Engineers: John Hays Hammond, Leonard Waldo and James Douglas; for the American Institute of Electrical Engineers: W. D. Weaver, M. I. Pupin and F. W. Jones. The committee has organized and has chosen Mr. Hammond for president and Mr. Suplee, of 140 Nassau Street, New York, for secretary. Regular meetings will be held on the first Tuesday of each month, except July and August.

—The American Society of Mechanical Engineers and the Institution of Mechanical Engineers (of Great Britain) will hold a joint meeting at Chicago from May 31st to June 3d. The professional sessions will begin on the morning of June 1st, when papers on the wages problem and on refuse destructors will be read and discussed. The evening of June 1st will be devoted chiefly to papers on steam turbines, the morning of June 2d to papers on power plants, superheated steam and gas-engine testing, and the morning of June 3d to papers on cast iron, strain and annealing, a lathe-tool dynamometer and locomotive testing. There will be a number of excursions to various places of interest, and the local committee has arranged a very complete social program for the entertainment of the visiting engineers and the ladies accompanying them.

—The Canadian business of the Allis-Chalmers Company, which recently acquired the Bullock Electric Manufacturing Company, of Cincinnati, will hereafter be conducted by a new organization bearing the name Allis-Chalmers-Bullock, Ltd. The works and principal offices of this important new Canadian company are in Montreal.

—Crocker-Wheeler Company, the manufacturers of electric generators and motors, will on May 10th open a branch office in the Hibernia Bank Building in New Orleans. Mr. W. P. Field, of the St. Louis office of the company, will be the representative in charge. Although there are fifteen Crocker-Wheeler branches from Boston to San Francisco, including St. Louis and Atlanta, this new office has been made necessary to accommodate the steadily increasing market for electric machinery in the South and Southwest.

—The Reeves Engine Company have just closed a contract with the Drew-Selby Company of Portsmouth, Ohio, for one of their 400 horse-power vertical cross-compound engines for direct connection to electric generator. Messrs. Plotner & Stoddard, of Dayton, Ohio, have also purchased a direct-connected 400-horse-power vertical cross-compound. The Reeves Company have sold to the International Steam Pump Company four direct-connected vertical cross compounds. The Trenton Mills & Elevator Company have purchased one of these large engines, and the Reeves Company have contracted with the Construction Realty Company to install three simple horizontal engines for direct connection to 65-kilowatt generators, for the latter's new hotel at Broadway and Sixty-ninth Street, New York.

—The Bristol Company, of Waterbury, Conn., have an exhibit at the World's Fair in St. Louis, which is located in Electricity Building. Their booth is situated by the main entrance, in space 36, where they show a complete line of their recording instruments for pressure, temperature and electricity. These instruments will be exhibited in the various styles and sizes which are manufactured, and in different finishes. The construction and operative parts will also be shown, and a large number of the instruments will be in actual operation, enabling visitors to observe the manner of operation and the records the instruments make, besides their extreme simplicity, and the delicacy and accuracy which it is possible to obtain without sacrificing any of the necessary elements which are essential in a commercial form of recording instrument. There will also be shown a complete line of specimens of Bristol patent steel belt lacing, which comprises over 150 different sizes for all kinds of belting, from the thinnest to the heaviest that is manufactured.

—The Brown Corliss Engine Company, of Corliss, Wis., have just received an order from the Phillips Insulated Wire Co., of Pawtucket, R. I., for two tandem compound condensing Corliss engines, one 14 and 28 by 42 inches, and the other 18 and 36 by 48 inches.

—The Henry R. Worthington Hydraulic Works, at the corner of Rapelyea and Van Brunt Streets, Brooklyn, are shortly to be removed to Harrison, N. J., to occupy the new $2,000,000 plant of the International Steam Pump Co., now nearly completed. The Brooklyn site consists of two city blocks, or about four and one-half acres, while the Harrison plant is located on a 35-acre tract, and contains 18 acres of floor space. The Worthington Company is one of the oldest and largest manufacturing concerns in Brooklyn, having been founded in 1843 by Henry R. Worthington, the inventor of the duplex steam pump and other hydraulic devices. About 2,000 men are employed in the South Brooklyn works, and many will undoubtedly go to the new plant at Harrison, which will accommodate from

5,000 to 6,000 men. The Brooklyn works will probably be sold, the company having already disposed of its large foundries at Elizabethport, N. J.

—The Watson-Stillman Company have moved their offices and a large stock of goods to 46 Dey Street, New York, and all of their machinery to their new works at Aldene, Union County, N. J. (four miles west of Elizabeth, and one-half mile from Roselle depot via trolley), where they will have ample room to expand and conveniently handle such work as may be given them.

—The Register of Lehigh University, South Bethlehem, Pa., just issued, copies of which may be had on application, shows the attendance of 615 students from 24 States and 10 foreign countries. There are 54 in the teaching staff. Thirteen four-year courses of instruction are offered at the University: the Classical Course, the Latin-Scientific Course, the courses in Civil, Mechanical, Marine, Metallurgical, Mining, Electrical and Chemical Engineering, Analytical Chemistry, Geology, Physics and Electrometallurgy. A list of graduates of the University, 1304 in number during the 38 years of its existence, indicates that this institution is exerting a very marked influence on the industrial development of the United States, and also of foreign countries. Provision is made for worthy and needy students whereby they may postpone payment of tuition until after graduation.

—The Lunkenheimer Company are issuing a handsome metal hanger, to be displayed by dealers who sell their steam specialties.

—The Boston & Maine Railroad issues, through its passenger department, an attractive set of summer publications descriptive of New England scenery and summer resorts, and has also published a convenient booklet containing a condensed summary of the fish and game laws of Maine, New Hampshire, Massachusetts, Vermont, Quebec, Nova Scotia, New Brunswick and Newfoundland.

—The summer school of the Thomas S. Clarkson Memorial School of Technology, at Potsdam, N. Y., will open on July 6, and will continue in session until August 17. Courses of instruction are offered in history and literature, physics and electricity, chemistry, photography, mathematics, home science and manual training. Detailed information will be furnished on application to The Secretary, Clarkson Summer School, Potsdam, N. Y.

—The William Tod Company, of Youngstown, Ohio, the builders of heavy-duty Corliss engines, pumping engines, blowing engines, hoisting engines and gas engines, have established an office at 29 Broadway, New York, and have appointed as their Eastern agent Mr. Geo. F. Woolston, formerly of Woolston & Brew.

—The Broderick & Bascom Rope Company, of St. Louis, have issued an attractive blotter for desk use, ornamented with designs illustrative of their wire-rope products, which they will distribute to their customers, who visit them at the St. Louis Fair.

—The Pennsylvania State College will begin its next college year on September 15. Examinations for admission will be held at the college, in Centre County, on June 16, and on September 13 and 14. Local examinations will be also be held on June 30 and July 1 at Philadelphia, in the Central Y. M. C. A. Rooms; in the high schools of Scranton, Johnstown, Erie, Harrisburg and Reading; and at Pittsburg, in the Central Board of Education. Further information may be obtained from The Registrar, State College, Centre County, Pa.

—The Lubrication Publishing Company, of Pittsburg, is bringing out a second edition of Mr. W. M. Davis's book on "Friction and Lubrication." The author has revised this work and added considerable new matter and illustrations, which will bring its size up to 250 pages.

—Dunham steam traps, manufactured by the C. A. Dunham Company, of Marshalltown, Iowa, are used in the power plant of the St. Louis Exposition. These traps are of two styles, namely low pressure, with by-pass, and standard, operating upon a pressure of 150 pounds above atmosphere, and if desired they can be fitted with a balanced valve by eliminating the by-pass feature, so enabling them to work equally well on high- and low-pressure steam.

—The Massachusetts Institute of Technology will hold its entrance examinations at the Rogers Building, 491 Boylston Street, Boston, on June 30 and July 1 and 2.

Examinations in other cities will be held by the College Entrance Examination Board from June 20 to 25. For further information concerning the latter, address Dr. Thomas S. Fiske, Secretary, College Entrance Examination Board, P. O. Sub-Station 84, New York. The M. I. T. offers a number of summer courses during June and July, supplementing the work of the regular college year. Any further information desired will be given by H. W. Tyler, secretary, Massachusetts Institute of Technology, Boston.

—An announcement has been made by the Joint Committee on the Union Engineering Building, which is to be erected by Andrew Carnegie for the American Society of Mechanical Enginers, the American Institute of Mining Engineers and the American Institute of Electrical Engineers, together with an adjoining building for the Engineers' Club, of New York, from which the following extracts are taken: "The preliminary work of the Conference Committee on the Union Engineering Building was closed April 15th, after a considerable amount of labor on the part of all interested, and the program of competition was placed in the hands of architects about May 1st. In this work the committee has enjoyed the advice of Prof. W. R. Ware, late of Columbia University, as professional adviser, and it is needless to say that the program has been drawn with great care. The Engineering Building on Thirty-ninth Street, about midway on the north side of the block, will occupy about 10,500 square feet, exclusive of the 15 feet open space reserved under the city ordinances, the outside dimensions of the land being about 125 feet by 100 feet. To the east of the building Mr. Carnegie has bought and reserved a residence, which will be maintained at its present elevation so as to protect the air and light of the building on that side. The general plans of the building may be briefly stated as follows: There will be at the top of the building three stories held for the use of technical societies invited to participate in the benefits of the building. Three other similar floors will be reserved, one each for the American Institute of Electrical Engineers, the American Institute of Mining Engineers and the American Society of Mechanical Engineers. These floors will make ample provision for offices, and each will have a large, handsome reception room, as well as board and committee rooms. Below these will be the library, virtually a double floor; although the committee will entertain plans placing the library at the top of the building. Next below will be a large main auditorium floor, which will seat from 1,200 to 1,500 people, with 1,000 on the floor and about half as many additional in the galleries. This floor will preferably be as near the sidewalk as possible, and may have above it or below it a number of smaller meeting rooms having similar purposes, seating audiences of from 500 down to 100. The floor on the street level will be appropriated mainly to administrative purposes, with three coat rooms capable of taking care of 1,500 garments at once, a ladies dressing-room, a bureau of information, public telephone and telegraph offices, the post office and other offices. For the purposes of the Engineering building and the Engineers' Club regarded as separate structures, it is proposed to expend about $1,000,000, leaving the other $500,000 for tearing down of old buildings, excavation, architects' and engineers' fees, machinery, elevators, lighting fixtures and the equipment of the library and auditorium." The following architectural firms have accepted the invitation of the Joint Committee to submit designs in the mixed competition: Ackerman & Partridge, Carrère & Hastings, Clinton & Russell, Lord & Hewlett, Palmer & Hornbostel, Whitfield & King. Each of these firms will receive $1,000, which is to be charged against the commission of the successful competitor. Any other architects will be permitted to compete and will be furnished with printed programs of the competition by the secretary of the committee, Prof. F. R. Hutton, of 12 West Thirty-first Street, New York. The competitors on the open list will receive prizes of $400 for each of the four best designs. The date for the filing of the competitive plans is June 20th, and as soon thereafter as possible the committee will make its decision, and will then proceed with the work without delay.

NEW CATALOGUES AND TRADE PUBLICATIONS

These catalogues may be had free of charge on application to the firms issuing them. Please mention The Engineering Magazine when you write.

Aerial Tramway.

Pamphlet containing a well-illustrated account of the Leschen Company's patent automatic aerial wire-rope tramway built for the North American Copper Co., at Encampment, Wyo. This aerial tramway is sixteen miles long and passes over the Continental divide at an altitude of 10,690 feet, and conveys the ores from the mines of the copper company to their smelter. 6 by 9½ in.; pp. 24. A. Leschen & Sons Rope Co., St. Louis.

Boilers.

Pamphlet containing illustrations and descriptions of the Milne high-pressure water-tube boiler and steam superheater. The construction of the boiler embodies feed-water re-heating or economizer tubes, and the whole design of boiler and superheater combines simplicity and efficiency. 11 by 8½ in.; pp. 10. Milne Boiler Company, 95-97 Liberty St., New York.

Coal Storage.

Large book, in flexible-cloth binding, with full-page illustrations on tinted paper, containing descriptions of various installations of the Dodge system for the stocking or trimming out of coal to be stored, both out-of-doors and in buildings, and the reloading from storage for further transport, both operations being performed by continuous conveyors. 11½ by 9 in.; pp. 55. The Dodge Coal Storage Company, Nicetown, Philadelphia.

Compressed-Air Cleaning.

Catalogue E, describing the Thurman "dustless" method of cleaning carpets, furniture, draperies, ceilings, walls and everything else in houses and other buildings, without removing them from their places, by means of compressed air, with many illustrations of the application of the system, and also of disinfecting, painting and grease-removing apparatus, besides lists of users and testimonials, 6¾ by 5 in.; pp. 102. General Compressed Air House Cleaning Co., St. Louis.

Compressed-Air Locomotives.

"Record of Recent Construction, No. 46," containing a very well illustrated account of compressed-air locomotives for mine haulage and other service, with descriptions of compressed-air haulage plants, comparative costs and other useful information. 6 by 9 in.; pp. 40. Baldwin Locomotive Works, Philadelphia.

Compressors.

Bulletin L 511, with illustrations and descriptions of compressors intended for pressures of 30 pounds and under, built with open suction for air or with closed suction for handling carbonic acid and other gases. The inlet valves are of the semi-rotary type and the outlet valves of the poppet type, and the steam-valve gears are of the Meyer or Corliss types. 9 by 6 in.; pp. 12. Laidlaw-Dunn-Gordon Co., 114 Liberty St., New York.

Concrete-Steel.

Pamphlet, containing an historical and descriptive account of the Ransome system of concrete-steel construction, in which the concrete is reinforced by twisted bars of steel, illustrated with many half-tones of buildngs, bridges and other structures built on this system, together with results of tests and much other information. 9 by 6 in.; pp. 75. Ransome Concrete Machinery Co., 11 Broadway, New York.

Conveyors.

Catalogue No. 57A, with illustrations and descriptions of conveying machinery and many details thereof especially adapted to the saw-mill, lumber and wood-working industries. 7¾ by 5½ in.; pp. 144. The Jeffrey Manufacturing Co., Columbus, O.

Corliss Engines.

Catalogue, with half-tone illustrations on heavy paper and descriptions of "Twin City" Corliss steam engines and their parts, of the works where they are manufactured and of some of the plants where they are installed. 7 by 9 in.; pp. 69. Minneapolis Steel & Machinery Co., Minneapolis.

Drawing Materials.

Catalogue and price-list, with illustrations and descriptions of drawing instruments, paper, tracing cloth, blue-print frames, electric blue-print machines, scales, drawing tables, transits, theodolites, levels, plane tables, current meters, tide gauges, and many other kinds of drawing materials and surveying instruments. 8½ by 5¾ in.; pp. 415. Eugene Dietzgen Co., Chicago.

Dynamos.

Circular No. 41, with illustrated description of a direct-current electric generator especially designed to be driven with gas or gasoline engines by means of belting. On the dynamo shaft is a heavy flywheel, which, with the generator, is supported by three bearings mounted on an adjustable iron base. 9 by 6 in.; pp. 2. Commercial Electric Co., Indianapolis.

Electric Locomotives.

Large pamphlet, No. 1045, containing handsomely illustrated descriptions of electric locomotives for coal, copper and other mines, for both surface and underground service, of installations in operation in many parts of the world, and of various details of locomotives and plants. 10½ by 8 in.; pp. 71. General Electric Co., Schenectady, N. Y.

Fan Motors.

Catalogue No. 38, with illustrations, descriptions and prices of "The Standard" electric fan motors, in desk, bracket, ceiling and oscillating styles, the latter automatically turning from side to side and delivering a current of air all about the room. 9 by 6 in.; pp. 12. The Robbins & Myers Co., Springfield, O.

Fireproof Construction.

Catalogue describing the Clinton fireproofing system, in which electrically-welded wire cloth is used to reinforce concrete, with illustrations of its application to floors, arches, ceilings, columns, roofs and other forms of construction, reports of tests and views of buildings. 6 by 9 in.; pp. 76. Clinton Wire Cloth Co., Clinton, Mass.

Flanges.

Circular E, with description, illustrations, prices and dimension table of high-grade, forged-steel flanges suitable for riveting to pipe and sheet iron work. 11 by 8½ in.; pp. 2. American Forged Steel Flange Co., Chicago.

Forge.

Booklet, entitled "Annealing, Hardening, Tempering and Case Hardening," containing descriptions and illustrations of Braun's portable forge and temperng furnace and of the Cary hydrocarbon burner, which operates the forge, together with much useful information. 6 by 3½ in.; pp. 16. F. W. Braun Co., Los Angeles, Cal.

Gasoline Traction Engines.

"Blue Book" with illustrated descriptions of gasoline engines having an oil-cooling system, for stationary and portable service, and of gasoline traction engines for agricultural and other uses, which possess many strong points and have proved their merit in practical operation. 9 by 6 in.; pp. 31. Hart-Parr Co., Charles City, Iowa.

Gas Producers.

Catalogue No. 19, containing descriptions and illustrations of the Weber suction gas producer which uses charcoal, coke, anthracite coal and other fuels, of gas engines, and of complete gas power plants, with useful information and tables. 8 by 11 in.; pp. 12. Weber Gas & Gasoline Engine Co., Kansas City, Mo.

Hand Blowers.

Booklet, with illustrations and descriptions of geared hand blowers for furnishing blast for forges and other purposes, portable forges, and other blacksmith tools and appliances. 6¼ by 3½ in.; pp. 8. Buffalo Forge Co., Buffalo.

Machine Tools.

Catalogue T, containing illustrations and descriptions of punches, shears, beveling and clipping machines, rail-straightening press, plate-bending rolls, plate-straightening machines, plate-planing machines, and other machine tools for working plates, bars and structural shapes. 9 by 9 in.; pp. 28. Hilles & Jones Company, Wilmington, Del.

Metal Structures.

Catalogue containing descriptions and half-tone illustrations of elevated water tanks, water towers, stand pipes, railway water tanks, smoke stacks, large riveted pipe, bridges and other metal structures, with tables of fire-stream data for various sized nozzles. 6¾ by 5 in.; pp. 62. Chicago Bridge & Iron Co., Washington Heights, Chicago.

Pumping Machinery.

Catalogue K-104, containing illustrations and descriptions of pumping machinery for beet sugar factories, including feed pumps, tank pumps, vacuum pumps, power pumps, air compressors and other apparatus. 7¼ by 5¾ in.; pp. 65. Knowles Steam Pump Works, New York.

Rheostats.

Several catalogues, bound together, with illustrations and descriptions of electric-motor starters, automatic motor speed controllers, dynamo field rheostats, sparkless controllers for printing-press motors, resistance units, theatre dimmers, and other kinds of electric resistances, switches and circuit breakers. 10½ by 8 in. Ward Leonard Electric Co., Bronxville, N. Y.

Steam Engines.

Catalogue, with half-tone illustrations on tinted paper and descriptions of blowing engines, reversing engines, Corliss engines and automatic engines for rolling mill and electric power service. 7 by 10¾ in.; pp. 20. Wm. Tod Co., Youngstown, O.

Steam Turbines.

Catalogue, containing half-tone illustrations and descriptions of Westinghouse-Parsons steam turbines and various plants where they are installed, with comparisons between the steam turbine and the reciprocating engine, and an exposition of the many advantages of the former. 9 by 6 in.; pp. 46. The Westinghouse Machine Co., East Pittsburg.

Storage Batteries.

Bulletin No. 80, containing an illustrated article by John Murphy, reprinted from *The Electrical World and Engineer*, on the installation of "chloride" accumulators at the hydro-electric power plant of the Ottawa (Canada) Electric Railway Company. 10½ by 8 in.; pp. 8. The Electric Storage Battery Co., Philadelphia.

Street Railway Signals.

Bulletin No. 1, with illustrated description of a standard automatic non-interfering, two-line-wire, block signal system, which is applicable to all electric railway systems and is especially adapted for single-track trolley roads. 10½ by 8 in.; pp. 12. Uni Signal Company, Cambridge, Mass.

Valves.

Illustrated catalogue and price-list, containing descriptions of gate valves in iron and bronze, "lenticular" valves, hose valves and Siamese connections, indicator devices for automatic sprinkler systems, hydrant mains, fire pumps, etc., indicator post valves, globe, angle, radiator and corner valves, hydrants, and other styles of valves for water, steam, ammonia, garbage, gas and other substances. 5 by 9 in.; pp. 128. The Kennedy Valve Manufacturing Co., 57 Beekman St., New York.

Zinc.

Pamphlet, entitled "Two Stories of Zinc," containing a reprint from *The Lead and Zinc News* which gives well illustrated and interesting accounts of the extraction of "spelter" or metallic zinc, from its ores, and of the manufacture of sheet zinc; and also a map showing the zinc mining districts and zinc smelters in the United States. 9 by 5 in.; pp. 24. Lanyon Zinc Company (F. E. Drake, President), St. Louis.

IMPROVED MACHINERY

New Processes and Appliances

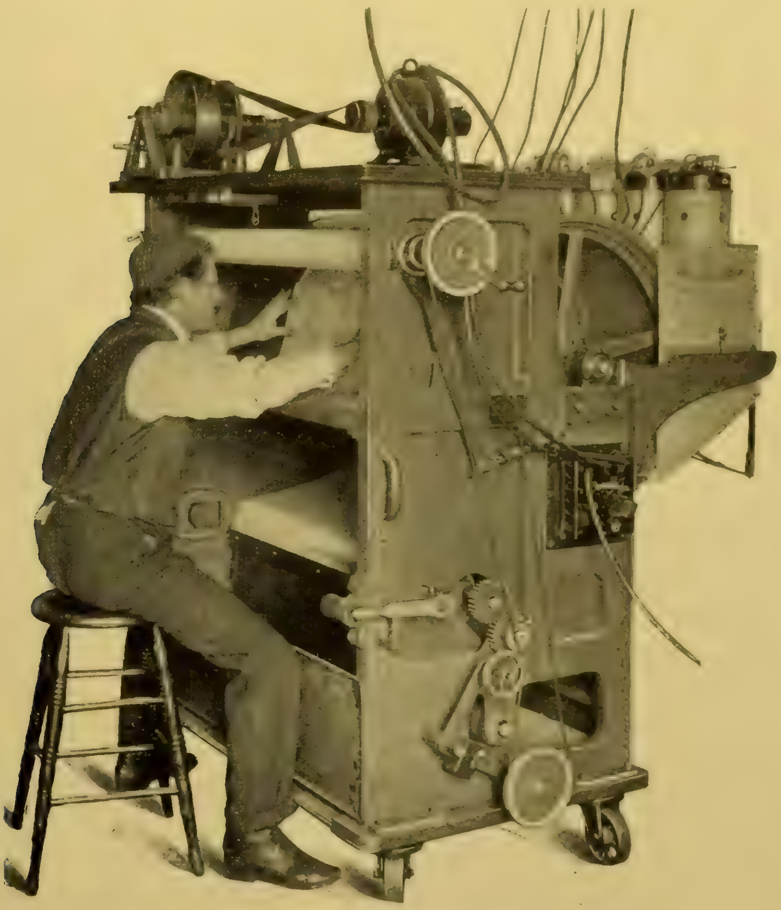
The matter here published is not paid for, nor can it be classed as advertising. But as the information is necessarily obtained from those who offer the appliances for sale, it is proper to say that the manufacturers, rather than ourselves, are responsible for the statements made.

Federal Blue-Printing Machine.

THERE are so many inconveniences in making blue prints in the old way with flat frames and sunlight exposure, that blue-printing machines, employing improved methods, are rapidly coming into use, and among the best of the new apparatus of this kind is the Federal machine.

The principal on which this apparatus works is shown clearly in the cross section on the next page. Its principal parts consist: first, of a drum revolving freely in roller-bearings; second, a feed or let-off roll above said drum, and carrying a long, transparent, flexible apron; third, a pair of pulling-rolls under the drum and connected to the source of power through a patent speed-controlling mechanism.

The transparent apron is drawn from the feed-roll against a tension device, around the surface of the drum, surrounding the latter about half of its circumference. The transparent apron, which is in contact with the face of the drum, constitutes the exposing-surface for printing.



FEEDING THE FEDERAL BLUE-PRINTING MACHINE.

The tracings and blue-print paper are fed between the apron and surface of drum at the top of the machine, and being carried around as the drum revolves, are exposed to the action of either sun or electric light, and afterward drop out automatically into a box provided for the purpose.

The transparent apron consists simply of a roll of tracing-cloth, wound upon the let-off roll, and passing around the periphery of the drum to two pulling rolls, and then to a take-up roll which winds it up automatically as fast as used. After its entire length has been drawn around through the machine, it is re-wound in two three minutes, ready for another run of exposures.

Tracing cloth, when in close contact with the work, will transmit rays of light in practically the same time as plate glass. With ordinary care it will last indefinitely. It has the advantage also of being renewable at any time with little trouble, and at a small fraction of the cost of plate glass.

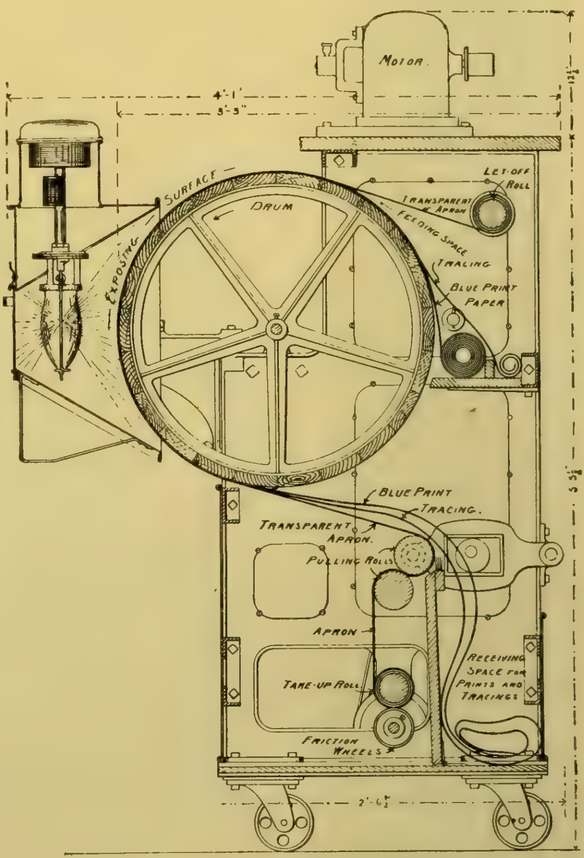
The size of blue prints that can be taken on this machine is limited only by the width of the drum and the length of the apron. The ordinary roll of tracing cloth is 24 yards long, which will be found sufficient for almost any drawing made, but double-length rolls, 30 and 42 inches wide, can be furnished, if desired.

Exposures may be made by this machine either on a continuous roll of blue-print paper or on separate sheets. If a continuous roll is used, the end of the paper is started under the transparent apron on the upper surface of the drum, and the tracings placed one after another upon it as the drum revolves. The chemical side of the paper is toward the operator; the tracing is placed right side up, on its surface; he can see just where to place his tracing with relation to the blue-print paper, and there is no possibility of any slipping after it has commenced its exposure.

The speed of printing depends on three factors, the same as with the old method; viz., sensitiveness of blue-print paper, transparency of drawings, and amount of light available. In solar printing, under a bright sun at noon, the speed of this machine, using rapid printing-paper and ordinary tracings, is as high as that with which the operator can properly feed the tracings. It is found that four to six running feet per minute will require prompt work on the part of the operator to keep the machine "well fed."

The speed of the machine is under perfect control, however, and by simply moving a handle either to the right or to the left all the variations that may be required for fast or slow printing are instantly made while the machine is running.

In cloudy weather it is advisable to do all printing by electric light, as it saves an enormous amount of time and gives much more satisfactory results than dim daylight. With electric light, the amount of illumination remains practically constant, so that exposures may be accurately timed.



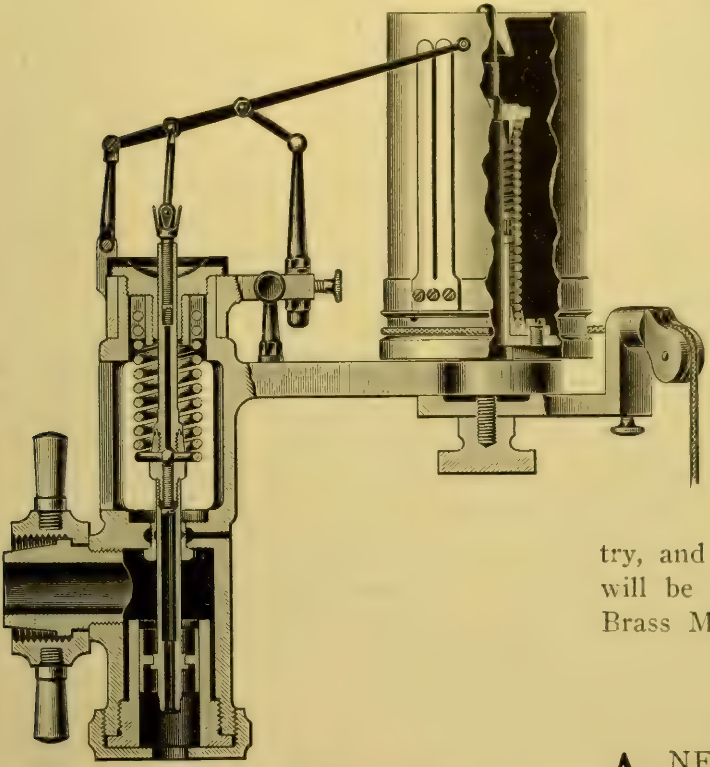
CROSS SECTION OF FEDERAL BLUE-PRINTING MACHINE.

The change is quickly made from electric to sunlight printing by slipping out the reflector which holds the lamps and removing two brackets from the machine. It is ready then for exposures to sunlight by rolling the machine out where the direct rays can fall on the exposing-surface of the drum. When it is desired to use the machine for electric printing again the brackets are put in place and the reflector slipped into position, and the change requires but a few moments.

Any further information that may be desired will be gladly furnished by the makers, the Spaulding Print Paper Co., Inc., of Boston.

Star Outside-Spring Indicator.

UPON the reliability of its spring depends the value of the steam-engine indicator as a means for measuring the power developed by an engine, and a spring which is subjected to compression and exposed to the action of high-pressure steam is not unlikely to have its accuracy seriously impaired.



STAR OUTSIDE-SPRING INDICATOR.

A consideration of the short-comings of the ordinary indicator has led to the designing of the instrument illustrated herewith. As can be seen, the spring is exposed to view and open to the air, so that it will not become unduly heated and it is elongated or pulled apart, instead of being compressed or even pushed apart. The piston of the indicator is at the end of the rod connecting it with the spring, so that the pull on the latter is in a perfectly straight line and there is a minimizing of friction.

The connection to the cylinder of the indicator is at the side instead of at the bottom as in other types, this style of connection causing steam to be taken on top of the piston. The cylinder can be readily removed for examination or replacement without in any way interfering with the other parts of the indicator. The end of the cylinder has no connection with the outer wall of the indicator, which allows the cylinder to be surrounded by live steam, which practically forms a steam jacket. By unscrewing the cap from the lower end of the cylinder, the piston can be removed with a socket wrench, for cleaning or oiling, without in any way disturbing other parts of the indicator.

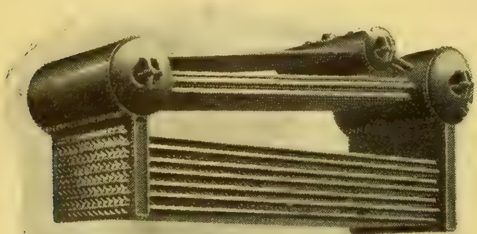
The operation of the pencil movement is directly opposite to that of the inside spring types, the atmospheric line being at the top of the drum instead of at the bottom.

The area of the piston has been reduced from one-half a square inch to a quarter of a square inch, so allowing the use of a much smaller size of wire for the spring, which secures greater elasticity and freedom of operation, and keeps down the weight of the moving parts.

The advantages of this type of indicator are so great that it has been adopted for use in many of the largest power plants and technical schools throughout the country, and further information concerning it will be gladly given by the makers, Star Brass Manufacturing Co., of Boston.

Atlas Boilers.

A NEW water-tube boiler has been placed on the market by the Atlas Engine Works, in which the builders believe they have eliminated practically all the difficulties heretofore experienced with this type of boiler. The boiler purifies its own feed water, superheats its steam and provides for a practically unimpeded circulation. It is a horizontal boiler, composed of two water legs, three drums running across the setting and connecting tubes. The rear and front drums are made of continuations of the same plates that form the rear and front water legs, a method of construction that prevents any seam of any kind from being exposed to the flame or hot gases. The legs open into these drums the full length of both legs and drums, thus avoiding the contraction at the throat which impedes circulation in so many of the water-tube boilers. In the rear drum is located a live-steam purifier, independent of the drum, and so arranged that it can be blown out at any time without interfering with the operation of the boiler. The generating tubes between the water legs are set on a slight incline and each is commanded by a separate handhole at each end. Equalizing tubes between the front and rear drums help to perfect the circulation and keep an equal water level in both these drums. Superheating tubes entering these drums above the water line carry the steam to the middle or steam drum, whence it is piped for use. The boiler is built in sizes ranging from 100 horse power up, and can be erected and shipped as a whole, or in sections, in which latter case, all the riveting is done at the shops and the tubes are expanded into the legs and drums after arrival.



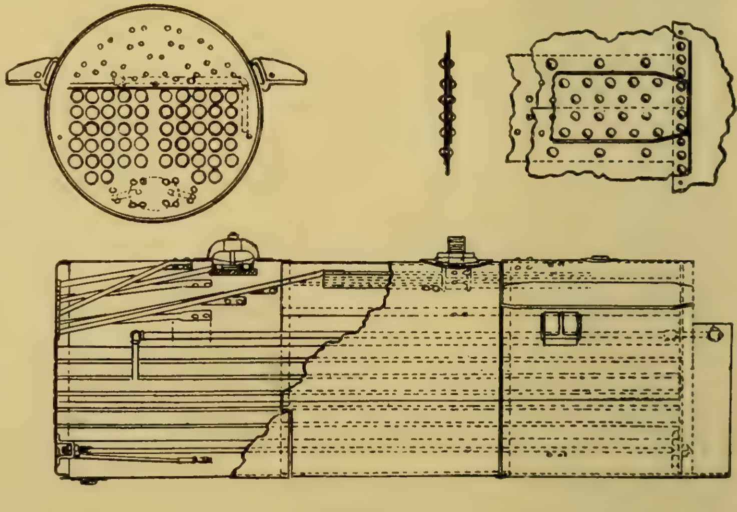
ATLAS WATER-TUBE BOILER.

The points of advantage claimed for the design are numerous. Not only dry, but superheated steam is assured, making it impossible to throw water into a cylinder or give wet steam. The purification of the water gives long life to the boiler and necessitates less fuel and labor. The facilities for cleaning are unsurpassed. Ample manholes give access to the drums, and all the tubes carrying water are straight and readily accessible. The superheating tubes, carrying steam only, are slightly curved to take care of the expansion. By geting all seams away from the fire and hot gases, the possibility of leaks at the rivets, or of plates cracking from the rivet holes to the edge is eliminated. The masonry required is simple and comparatively inexpensive, consisting of straight side walls and bridge walls, with no overhanging walls between or to the drums. Materials and workmanship throughout are the best.

The Atlas Engine Works has also added to its standard line of tubular boilers a new boiler of triple-riveted butt-strap construction for a constant working pressure of 125 pounds, to supply the demand for a boiler of intermediate pressure. It is built in seven convenient sizes, ranging from 48 inches by 14 feet, rated at 50 horse power, to 72 inches by 18 feet, rated at 150 horse power. The size, number and arrangement of the tubes is such as to insure good draft and excellent circulation. Details of riveting and bracing are fully shown by the line drawing. The boiler throughout is of high-grade materials and workmanship, and further details will be gladly furnished by the Atlas Engine Works, of Indianapolis.

Traverse Shaper with Pull-Cut Head.

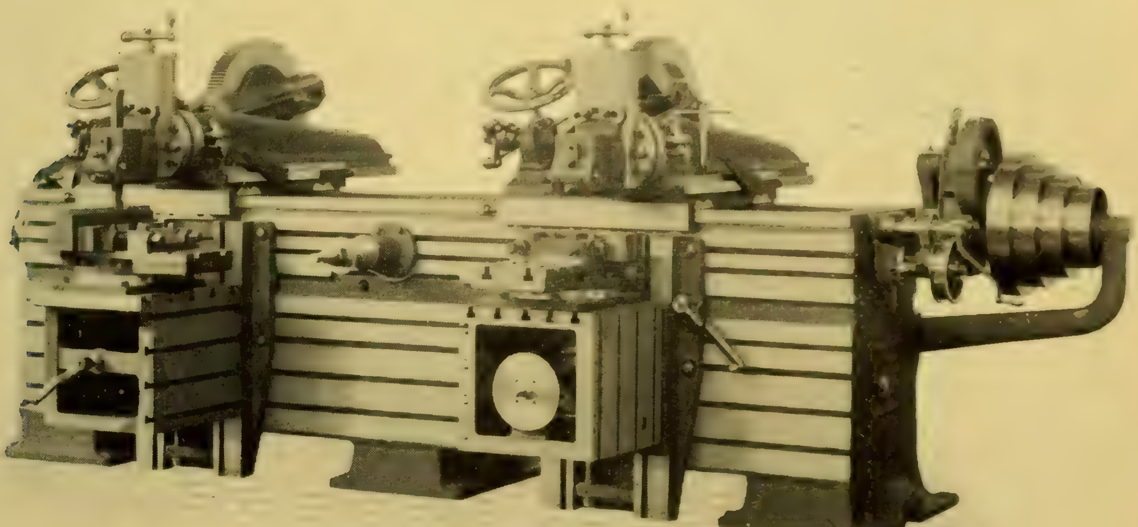
THE difference between this and the ordinary type of traverse shaper is that the cutting tools are reversed, the cutting taking place during the backward motion of the ram and quick return during the forward, the operation being directly opposite to that in the usual form.



ATLAS TUBULAR BOILER.

The advantage of this type is that the pressure or thrust of the tool is taken directly back against the bed of the machine, and tends to draw the table and apron more closely to the bed, rather than force them apart. This is of a decided advantage, especially when heavy cutting is being done, as is the case since the introduction of high-speed steels. Then, in many cases, the work itself can be pressed directly against the bed of the machine, so that the resistance to the cutting is not altogether dependent upon the hard clamping of the work and the table. Large pieces can also be directly bolted to the bed, the tables being removed.

The head is so constructed that the stress due to the cut comes directly upon solid metal contacts, and not upon threads, bolts or screw points, except in the case of the set screws for holding the tool. These screws are large in diameter, and have a long bearing. The whole construction of the head is one of great rigidity and strength, having the least possible tendency to yield or spring under the cutting strain. Except for the head, ram and such other modifications as have been deemed necessary, this traverse shaper is similar to the ordinary push-cut machine heretofore and still made by the Cincinnati Shaper Company, Cincinnati, Ohio, the introducers of this tool, who will be pleased to furnish any further information that may be desired.



CINCINNATI TRAVERSE SHAPER.

The Sturtevant Improved Hand Blowers.

IN these modern times men are always seeking devices by which they may accomplish the greatest results with the least exertion. To this fact, doubtless more than any other, was due the rapid introduction of the hand blower as a substitute for the old time bellows. During the years which have elapsed since this change, the B. F. Sturtevant Co., pioneers in the manufacture of blowers, have been perfecting their design and construction until their hand blower known as Style A has shaped itself into a new design known as Style B, as herewith illustrated.

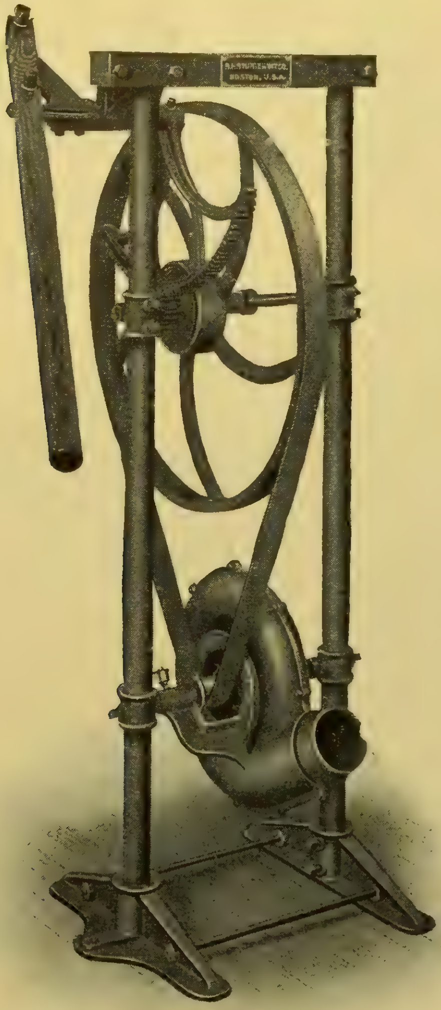
These hand blowers have been extensively introduced in connection with new forges of all kinds, and have likewise been applied to old style brick and iron forges as simple, efficient and economical substitutes for the bellows. Not only are they adapted to forge blowing, but they can also readily be applied as portable ventilating apparatus.

They are simple in design, strong, rigid and compact, easy and economical in operation and readily portable. The running gear is simple, effective and strong.

The blower is adjustable on the shaft and its outlet may thus be set to discharge in any direction and readily connected to the forge tuyere by means of galvanized iron piping. The blower is of cast iron strongly constructed in every particular, has a steel shaft running in babbitted boxes and a fan wheel of galvanized steel solidly riveted to a composition hub with extending arms.

The frame is carefully designed and well braced and is so arranged that the slackness of the belt driving the blower may be taken up by lowering the blower shaft which is supported by collars sliding on the frame. The feet are provided with holes so that the hand blower may be readily screwed to the floor.

These hand blowers are made in two sizes. The total length on the floor of Style B-1 is 18 inches, while the total height of the frame, not including the handle, is 48 inches. The driving wheel is 24 inches in diameter, the blower outlet is 3½ inches in diameter and the complete outfit weighs but 135 pounds.



STURTEVANT HAND BLOWER.

Style B-2 is of slightly larger dimensions and has proportionately greater capacity for delivering air. The blower outlet is 4¾ inches in diameter and the weight is 155 pounds. Further information will be cheerfully supplied by the B. F. Sturtevant Co., of Boston.

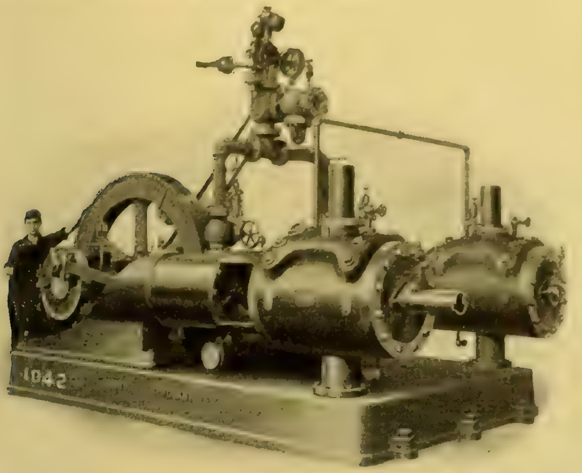
Air Compressors on Hudson River Tunnel Work.

WHILE several other tunnels are in the course of construction under the Hudson and East Rivers to connect Manhattan Island with its neighboring communities, the completion of the original so-called "Hudson River" tunnel, under the charge of Chief Engineer C. M. Jacobs, has attracted unusual attention. From the start compressed air was used, not only to operate the rock drills, but to hold back the sand and mud and overcome the obstacles which make subaqueous tunneling so hazardous. The developments of the shield system of tunneling, in which compressed air is absolutely essential, came as the tunnel advanced, and the methods which proved successful in this instance have since been adopted for other undertakings of a similar nature and are now meeting all the requirements of the work.

It is an interesting fact that from the time the Hudson River tunnel was started thirty years since, up to the completion of the first bore a few weeks ago, Ingersoll-Sergeant machinery has been used. The building of this tunnel marks the period of development in the air compressor, and at this time when the work is nearing completion, there may be seen in operation both the old and the new types of air compressors. The compressors used at the start of the undertaking were of the old water-injection type. As the work progressed these were replaced by the newer machines, with poppet inlet valves and water-jacketed cylinders. When the Hudson Improvement Company began operations two years ago, a complete equipment of modern Ingersoll-Sergeant compressors was installed, and has since supplied all the air necessary in the headings on both sides of the river.

There are two power houses, one in Jersey City and the other in New York. The Jersey City power house contains four compressors, one of the Class "H" duplex type, with steam cylinders 16 inches in diameter and duplex air cylinders 20½ inches in diameter by 16 inches stroke, and three of the Class "A" straight-line type, with 22 inches steam cylinders and 24 inches stroke. Of the latter, two have air cylinders 26¼ inches in diameter and the third has an air cylinder 22¼ inches in diameter.

The equipment of the New York power house, at the foot of Morton Street, includes two duplex Class "H" compressors similar in size to the one at the Jersey end of the tunnel, and one straight-line Class "A" machine with steam cylinders 22 inches in diameter, air cylinders 22¼ inches in diameter, and 24 inches stroke.



INGERSOLL-SERGEANT DUPLEX AIR COMPRESSOR.

Now that the first bore is completed, these machines are being used in building the second one, which is to be parallel to the other.

Further information concerning this compressed-air machinery will be gladly supplied by the Ingersoll-Sergeant Drill Co., of 26 Cortlandt St., New York.

Portable Forge and Furnace.

On account of its many good points, the Braun portable forge and tempering furnace, which is shown in the accompanying illustration, will be of great interest to metal workers generally. This apparatus is portable in the widest sense. It can be easily moved from one place to another about the workshop without disturbing it.

When desired, the fuel tank and burner can be detached and taken to any convenient spot for use. When shipped it is knocked down and can be packed in a number of parcels, which makes it easy to transport to any point.

The fuel used in Braun's Portable Forge is gasoline, which is burned in a Cary hydrocarbon burner. This gives a flame of unusual intensity which, with the peculiar construction of the furnace and forge, adapts it to a wide range of uses. The operation of the furnace is extremely economical, the gasoline being burned under air pressure in a manner that produces almost perfect combustion, only three quarts of gasoline per hour being required to keep the burner running at its normal capacity.

Heating, hardening and tempering are accomplished with unusual and uniform success, and the detached burner is most satisfactory for brazing and other forms of special shop work.

The Braun portable forge and furnace takes up very little room and can be put into any shop, no matter how cramped the quarters. It occupies a floor space 23 by 23 inches and stands 48 inches high.

It is so constructed that the gasoline tank, which is 9 inches in diameter and 17 inches high, rests on a shelf between the legs of the furnace, and is therefore included within the above measurements.

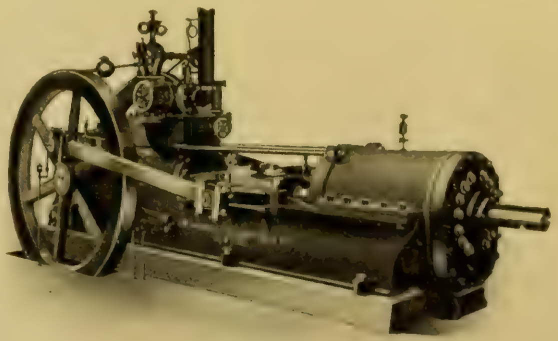
The size of the furnace proper is 16 by 19 inches and it is 18 inches high.

The fire-clay portion of the forge and furnace contains two different compartments:

Below there is the forge. The flames are forced directly into the forge and it is used for heating metals in direct contact with the flame.

Above is the muffle. The flame does not enter the muffle, which is heated through its fire-clay walls. This is used for annealing and similar operations.

The inside of the muffle is 4 inches high, 6 inches wide and 11½ inches long, and it has an arched roof. The dimensions of the forge are the same.

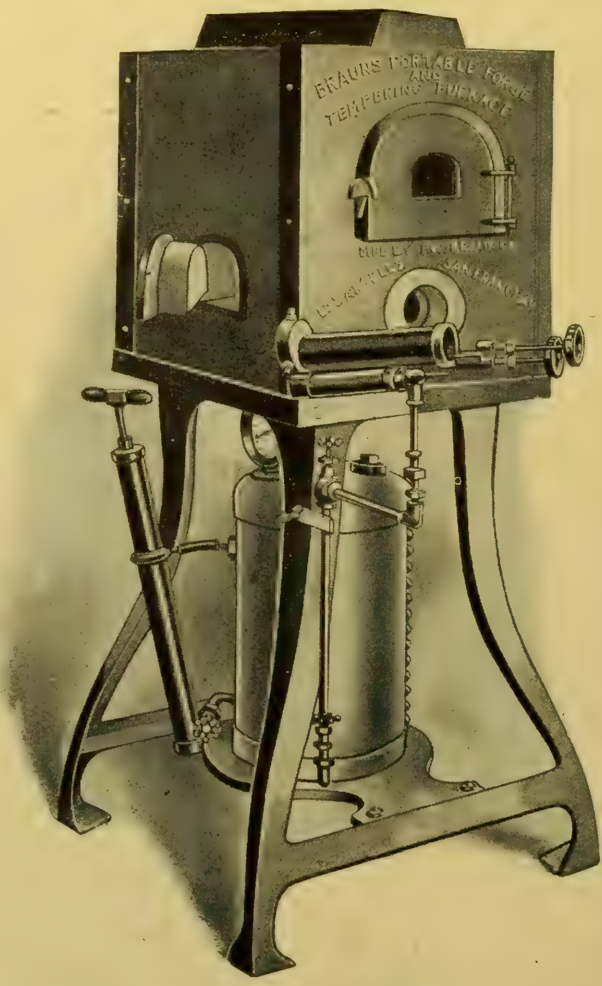


INGERSOLL-SERGEANT STRAIGHT-LINE AIR COMPRESSOR.

In the forge there is a front opening where the flame enters, and openings on each side 3½ by 5 inches, which are closed by fire-clay plugs except when long work is being heated. These long pieces can be passed directly through the two side openings.

The muffle has a door in front 4 by 6 inches, with an isinglass center. There is also an opening in the back which is ordinarily closed by a slide. The slide may be removed to give a draft directly through the muffle when it is desired to cool it quickly.

The flames from the Cary burner enter the forge under pressure, pass down through the length of it, and strike the rear wall, which is built in such a way as to turn the current of flame back along the ceiling of the forge, where it passes up through openings at the sides of the muffle until it reaches the ceiling over the muffle. Here it is deflected downward onto the top of the muffle. By this method of construction it will be seen that metal placed in the direct path of the flame will be heated alike in all parts on account of the impact of the direct flame and the reflected flame. It also follows that the muffle will be heated equally at every point.



BRAUN PORTABLE FORGE AND FURNACE.

There is only one tank used in connection with this portable forge and tempering furnace, for the fuel tank is also a chamber for the air, and the pump is permanently attached to the tank, so that there are only two pieces of apparatus to think about, the combination air-and-fuel tank and the forge-furnace.

In the Cary burner the fuel and the air are mixed and commingled in an entirely original manner. There is no obstructing surface as in other types of burners upon which the gas and air are impinged to break them up. This breaking up is accomplished by the sudden expansion which follows contraction under pressure, in addition to the concussion of hydrocarbon gas upon the air.

The mixing tube of the Cary burner is of such shape and size that the air is drawn into it by the jet of gas under pressure and in exactly the right proportions to insure complete combustion.

Among the advantages of using this burner in connection with metal work may be mentioned:

The complete absence of oxidation.

Uniform distribution of heat in the muffle, and even heating of all sides of the metal placed in the forge.

Perfect regulation of temperature.

Over-heating entirely prevented.

No danger of cracking the work.

Uniform conditions which can be repeated at will.

Economy, because the fire burns only when actual work is being accomplished.

Availability, because the heat can be ready in three minutes, extinguished instantly, and moved about at will.

For an occasional job away from the shop, this portable burner and tank solves what has been a difficult problem.

Further particulars regarding the whole apparatus and the many uses to which it can be put will be gladly furnished by the F. W. Braun Co., Los Angeles, Cal.

NEWS SUPPLEMENT

The Engineering Magazine—July, 1904

Coming Society Meetings.

American Boiler Manufacturers' Association. Sec.: J. D. Farasey, Cleveland. Next meeting, Oct. 4-6, at St. Louis.

American Institute of Electrical Engineers. Sec.: Ralph W. Pope, 95 Liberty St., New York. Convention, Sept. 12-17, St. Louis.

American Institute of Mining Engineers. Sec.: R. W. Raymond, 99 John St., New York. Next meeting in the Lake Superior iron and copper region, beginning Sept. 14, at Duluth.

American Institute, Polytechnic Section. Sec.: George Whitefield, Jr., 19 W. 44th St., New York. Meetings on first and third Tuesdays of each month, from October to May, inclusive.

American Railway Association. Sec.: W. F. Allen, 24 Park Place, New York. Next meeting, Oct. 26, at Philadelphia.

American Railway Mechanical and Electrical Association. Sec.: Walter Mower, Detroit. Annual meeting, Oct. 10-15, at St. Louis.

American Society of Civil Engineers. Sec: C. W. Hunt, 220 W. 57th St., New York. Regular meetings, first and third Wednesdays of each month, except July and August.

American Street Railway Association. Sec.: T. C. Penington, 2020 State St., Chicago. Annual meeting. Oct. 10-15, at St. Louis.

Association of Railway Superintendents of Bridges and Buildings. Sec. S. F. Patterson, Concord, N. H. Annual convention, Oct., at Chicago.

Boston Society of Civil Engineers. Sec.: S. E. Tinkham, 715 Tremont Temple. Regular meetings on third Wednesday of each month, except July and August.

Brooklyn Engineers' Club. Sec.: J. Strachan, 191 Montague St. Regular meetings on second Thursday of each month.

Canadian Railway Club. Sec.: W. H. Rosevear, Jr., Montreal. Regular meetings on first Tuesday of each month, except June, July and August.

Canadian Society of Civil Engineers. Sec.: Prof. C. H. McLeod, 877 Dorchester St., Montreal. The General Section and the Electrical, Mechanical and Mining Sections meet on different Thursdays, from October to May.

Central Railway Club. Sec.: Harry D. Vought, 62 Liberty St., New York. Regular meetings on second Friday of January, March, May, September and November, Hotel Iroquois, Buffalo.

Chicago Electrical Association. Sec.: W. B. Hale, Monadnock Building. Regular meetings on first and third Fridays of each month, from October to May.

Civil Engineers' Club of Cleveland. Sec.: Joseph C. Beardsley, 689 The Arcade. Regular meetings on second and fourth Tuesdays of each month.

Civil Engineers' Society of St. Paul. Sec.: G. S. Edmondstone. Regular meetings on second Monday of each month.

Engineering Association of the South. Sec.: Robt. L. Lund, 2102 Hayes St., Nashville, Tenn. Regular meetings on second Thursday of each month at the Berry Block. Convention at St. Louis.

Engineers' Club of Chicago. Sec.: B. W. Thurtell, 1223 New York Life Building. Regular meetings on first and third Tuesdays of each month.

Engineers' Club of Cincinnati. Sec.: J. F. Wilson, P. O. Box 333. Regular meeting on third Thursday of each month, except July and August.

Engineers' Club of Columbus (Ohio). Sec.: H. M. Gates, 5½ West Broad St. Regular meetings on third Saturday of April, May, June and September, and on first and third Saturdays from October to March, inclusive.

Engineers' Club of Minneapolis. Sec.: Jas. B. Gilman, American Bridge Co. Regular meetings on third Monday of each month, except July and August.

Engineers' Club of Philadelphia. Sec.: J. O. Clarke, 1122 Girard St. Regular meetings on first and third Saturdays of each month, except July and August.

Engineers' Club of St. Louis. Sec.: H. J. Pfeifer, 920 Rialto Bldg. Regular meetings on first and third Wednesdays of each month.

Engineers' Society of Western New York. Sec.: H. B. Alverson, 533 Ellicott Square, Buffalo. Regular meetings on first Tuesday of each month, except July and August.

Engineers' Society of Western Pennsylvania. Sec.: Chas. W. Ridinger, 410 Penn Ave., Pittsburg. Regular meetings on third Tuesday of each month.

Franklin Institute. Sec.: Dr. Wm. H. Wahl, 15 South 7th St., Philadelphia. General meetings on third Wednesday of each month, except July and August. General section meetings every Thursday.

International Association of Municipal Electricians. Sec.: Frank P. Foster, Corning, N. Y. Meeting, Sept. 13-14, at St. Louis.

INTERNATIONAL ELECTRICAL CONGRESS. Sec.: Dr. A. E. Kennelly, Harvard University, Cambridge, Mass. Meeting, Sept. 12 to 17, at St. Louis.

INTERNATIONAL ENGINEERING CONGRESS. Sec.: Charles Warren Hunt, 220 W. 57th St., New York. Meeting, Oct. 3 to 8, at St. Louis.

IOWA RAILWAY CLUB. Sec.: P. B. Vermillion, Des Moines, Iowa. Regular meetings on third Tuesday of each month.

IRON AND STEEL INSTITUTE. Sec.: B. H. Brough, 28 Victoria St., London, S. W. Annual meeting, Oct. 24-26, at New York.

LOUISIANA ENGINEERING SOCIETY. Sec.: G. W. Lawes, 806 Gravier St., New Orleans. Regular meetings on second Monday of each month.

MONTANA SOCIETY OF ENGINEERS. Sec.: Clinton H. Moore, Butte, Mont. Regular meetings on second Saturday in each month.

NATIONAL ELECTRICAL CONTRACTORS' ASSOCIATION OF THE UNITED STATES. Sec.: W. H. Morton, Utica, N. Y. Annual convention, Sept. 14-16, at St. Louis.

NATIONAL ELECTRIC LIGHT ASSOCIATION. Sec.: Ernest H. Davis, 136 Liberty St., New York. Meeting, Sept., at St. Louis.

NEW ENGLAND RAILROAD CLUB. Sec.: Edw. L. Janes, Back Bay P. O., Boston. Regular meetings, second Tuesday in each month, except June, July, August and September, at Pierce Hall, Copley Square.

NEW YORK ELECTRICAL SOCIETY. Sec.: Geo. H. Guy, 114 Liberty St., New York. Meetings monthly, on different Wednesdays, at the American Institute, 19 W. 44th St.

NEW YORK RAILROAD CLUB. Sec.: Harry D. Vought, 62 Liberty St., New York. Regular meetings on third Friday of each month, except June, July and August, at Carnegie Hall, 154 W. 57th St., New York.

NEW YORK STREET RAILWAY ASSOCIATION. Sec.: W. W. Cole, Elmira. Annual meeting, Sept., at Utica.

NORTHWESTERN ELECTRICAL ASSOCIATION. Sec.: Thos. R. Mercein, Milwaukee. Annual convention, Sept., at St. Louis.

NORTH-WEST RAILWAY CLUB. Sec.: T. W. Flannagan, Minneapolis, Minn. Regular meetings on first Tuesday after second Monday of each month, except June, July and August, alternating between Minneapolis and St. Paul.

PACIFIC COAST ELECTRICAL TRANSMISSION ASSOCIATION. Sec.: Geo. P. Low, 237 Cherry St., San Francisco. Annual convention, third Tuesday in June. Intermediate meetings subject to call.

PACIFIC COAST RAILWAY CLUB. Sec.: C. C. Borton, West Oakland, Cal. Regular meetings on third Saturday of each month at San Francisco and other cities.

PACIFIC NORTHWEST SOCIETY OF ENGINEERS. Sec.: Prof. M. Roberts, Seattle, Wash. Meetings monthly in Chamber of Commerce rooms, Seattle. Annual convention, July 1-5.

RAILWAY CLUB OF PITTSBURG. Sec.: J. D. Conway, P. & L. E. R. R., Pittsburg, Pa. Regular meetings on fourth Friday of each month, except June, July and August, at Hotel Henry.

RAILWAY SIGNAL ASSOCIATION. Sec.: B. B. Adams, 83 Fulton St., New York. Regular meetings on second Tuesdays of January, March, May, Sept. and Nov. Next meeting, Sept. 13, at Chicago. Annual meeting, Oct. 11, at St. Louis.

RAILWAY WATER SUPPLY ASSOCIATION. Sec.: F. W. Hayden, Glencoe, Minn. Meetings on first Sunday of each quarter at Alexander Hall, South Minneapolis, Minn.

RICHMOND RAILWAY CLUB. Sec.: F. O. Robinson, 8th & Main Sts., Richmond, Va. Regular meetings on second Thursday of each month, except June, July and August.

ROADMASTERS' AND MAINTENANCE OF WAY ASSOCIATION. Sec.: J. C. Rockhold, Stockton, Cal. Annual meeting, Sept., at St. Louis.

ROCKY MOUNTAIN RAILWAY CLUB. Sec.: M. M. Currier, Colorado City. Regular meetings on second Tuesday of each month, except June, July and August, at Union Depot, Denver.

ST. LOUIS RAILWAY CLUB. Sec.: E. A. Chenery, Union Station, St. Louis. Regular meetings on second Friday of each month, except July and August.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION. Sec.: C. A. Waldo, Purdue University, Lafayette, Ind. Annual convention, Sept. 1-3, at St. Louis.

SOUTHERN AND SOUTHWESTERN RAILWAY CLUB. Sec.: W. A. Love, Atlanta, Ga. Regular meetings on third Thursday of Jan., April, Aug. and Nov., at Atlanta.

TECHNICAL SOCIETY OF THE PACIFIC COAST. Sec.: Otto von Geldern, 31 Post St., San Francisco. Regular meetings on first Friday of each month.

TEXAS RAILWAY CLUB. Sec.: T. H. Osborne, Pine Bluff, Ark. Regular meetings on third Monday of April and September.

TOLEDO SOCIETY OF ENGINEERS. Sec.: L. M. Gram, 519 Gardner Building, Toledo, O. Meetings on third Friday of each month in National Union Building.

TRAVELING ENGINEERS' ASSOCIATION. Sec.: W. O. Thompson, Oswego, N. Y. Next meeting, Sept. 13, at Chicago.

WESTERN RAILWAY CLUB. Sec.: J. W. Taylor, 667 Rookery, Chicago. Meetings on third Tuesday of each month, except June, July and August, Auditorium Hotel, Chicago.

WESTERN SOCIETY OF ENGINEERS. Sec.: J. H. Warder, Monadnock Block, Chicago. Regular meetings on first Wednesday and extra meetings on third Wednesday of each month, except July and August.

Personal.

—Mr. Allen Hazen begs to announce that he has formed a partnership with Mr. Geo. C. Whipple, formerly director of the Mount Prospect laboratory of the Department of Water Supply, Gas and Electricity, of the City of New York. A department of testing and operating filters will be established and will be in charge of Mr. Whipple. Investigations as to the quality of water supplies and the means for their improvement will be undertaken. The offices of Messrs. Hazen and Whipple are at 220 Broadway, New York.

—Mr. Morris R. Sherrerd, engineer and superintendent of the Water Department of Newark, N. J., was elected president of the American Water Works Association at the St. Louis Convention, held in June.

—Dr. Hermann von Schrenk, the well-known expert in economic forestry, who is in charge of the division of Forest Products in the United States Bureau of Forestry, is the author of a report on "Cross-Tie Forms and Rail Fastenings, with Special Reference to Treated Timbers," which has been issued as Bulletin No. 50 of the Bureau of Forestry.

—Mr. J. C. McQuiston, until recently secretary, has been appointed superintendent of the The Westinghouse Companies' Publishing Department, having charge of matters relating to the publicity of the products of the various Westinghouse interests in the United States and Canada.

—Signor Enrico Bignami, the well-known Italian engineer and writer, has been invited to present a paper before the International Electrical Congress at St. Louis in September, on the electrical installations of Switzerland.

—Mr. A. M. Mattice, chief engineer of the Allis-Chalmers Co., has returned from his European tour of inspection, and has now settled down to the duties of his position in Milwaukee.

—Mr. B. Franklin Hart, Jr., begs to announce that he has severed his connection with Mr. Edwin Burhorn, and has established himself under the firm name of B. Franklin Hart, Jr., & Co., with offices at 143 Liberty Street, New York. B. Franklin Hart, Jr.. & Co. are manufacturers of boilers, stacks, tanks, and all manner of plate steel construction. They have fully equipped pattern, foundry and machine shops, in connection with the boiler shop, and are prepared to make castings of all descriptions, finished or unfinished.

—Mr. John B. Allan, formerly vice-president and general manager of the Allis-Chalmers Company, will shortly commence his duties as western manager of The Westinghouse Machine Company, with headquarters at 171 LaSalle Street, Chicago, having direct charge of the entire western district. Mr. Allan has been prominently associated with the Allis-Chalmers Company for the past twenty-four years, and has filled postions of progressively increasing importance, including those of sales manager, general manager, and vice-president.

—Mr. F. P. Thorp, who has been representing the Power and Mining Machinery Company, of New York, at Boston, is now in charge of the Pittsburg office of that company in the Farmers' Bank Building.

Mr. Paul M. Mowrey, who for the last three years has been connected with the Merchants' Trust Company as adviser on industrial investments, has assumed the office of vice-president of the Engineering Company of America, 74 Broadway, New York.

—Mr. Robert McF. Doble, of San Francisco, consulting and supervising engineer, making a specialty of hydro-electric power developments and long-distance power transmission, has become identified with the Abner Doble Company, engineers and manufacturers of tangential water wheels with needle regulating nozzles.

—Mr. H. F. Frevert, who for the past several years has been manager of the New York stores of the Niles-Bement-Pond Co. and the Pratt & Whitney Co., has severed his connection with these companies and has opened an office at 114-118 Liberty Street, for the sale of machinery. He is also manager of the New York office of the Norton Grinding Co., of Worcester, Mass., manufacturers of emery grinding machinery, and of the Brightman Mfg. Co., of Shelby, Ohio, manufacturers of turned shafting and of machines for turning, rolling, straightening and polishing shafting.

—Mr. C. C. Tyler has resigned his position as superintendent of the works of the Westinghouse Electric & Manufacturing

Co., at East Pittsburg, Pa., and has been appointed general superintendent of all the works of the Allis-Chalmers-Bullock interests in the United States. Mr. Tyler, who entered upon his new duties on June 15th, will make his headquarters at Milwaukee.

—Mr. David R. Fraser, one of the founders of what is now the Allis-Chalmers Company, died recently at his residence in Chicago.

—Mr. James A. Myers, president and treasurer of The Robbins & Myers Co., of Springfield, Ohio, died at his home in that city recently.

Mr. Clarke Merchant, the president and founder of Merchant & Co., Inc., of Philadelphia, and formerly lieutenant-commander in the U. S. Navy, died recently.

Industrial Notes.

—The main building of the Rensselaer Polytechnic Institute, at Troy, N. Y., which was used principally for recitation purposes, was practically destroyed by fire in the early morning of June 9th, but as the college year was about over, this did not prevent the finishing of the students' work and the closing ceremonies. Arrangements are being made to rebuild, although possibly in another location, and in the meantime recitations will be carried on in the other buildings of the R. P. I., and also, if necessary, in temporary quarters, and the president and trustees announce that the fire will not postpone the opening of the institute on September 14th, 1904, nor interfere with the regular work of the coming year, for the carrying on of which complete facilities will be afforded.

A movement is on foot to place a bronze bust of the late Professor Robert H. Thurston, temporarily in the present house of the American Society of Mechanical Engineers and permanently in the Union Engineering Building, when the latter is completed. The appropriateness of such a bust needs little argument. Professor Thurston was the first president of the society, and carried the burden of the inaugural work of its first years. As Professor of Mechanical Engineering at Stevens Institute he laid the foundation in mechanical engineering in United States technical schools, which has made them the admiration of Europe, and as the Director of Sibley College, at Cornell University, he made his impress on thousands of the younger generation of mechanical engineers. The privilege of subscribing to this memorial is not limited to members of the American Society of Mechanical Engineers, but any one wishing to take part may send his contribution to Mr. Gus C. Henning, 36 Gold Street, New York, who is the treasurer of a committee which includes also Messrs. John Fritz, Stephen W. Baldwin, R. C. Carpenter, Walter C. Kerr, E. A. Uehling and William Hewitt.

The Société des Ingénieurs Civils de France (French Society of Civil Engineers) will visit the United States this autumn. The members taking part in the excursion will leave Havre on August 20th, and will arrive in New York on August 27th. While in this country they will be divided into three parties. The itinerary of the first will comprise Niagara Falls, Pittsburg, Chicago, St. Louis, Cincinnati, Washington, Baltimore, Boston, the Berkshire Hills and New York, from which the departure for Havre will be made on September 29th. The second party will travel with the first as far as Chicago, and will then go through St. Paul to the Yellowstone Park, Salt Lake City and Colorado Springs, and then to St. Louis. The itinerary of the third party will be the same as that of the second to beyond Yellowstone Park, and will also include a trip to the Pacific Coast, where Portland, San Francisco and the Yosemite Valley will be visited. From St. Louis eastward the second and third parties will follow substantially the same route as the first, the second party sailing from New York on October 6th, and the third on October 13th. Each party will spend about a week at the St. Louis Exposition, and side trips to New Orleans and to Canada are also offered, while members may make arrangements to prolong their stay in the United States beyond the dates fixed.

—The Crocker-Wheeler Company announce that the equipment of factories with electric motors for individual and group drive of machine tools has become such an extensive department of their business that they are warranted in going a step further. They are now prepared to give their clients expert advice upon the latest ideas and results in shop practice in addition to purely engineering advice upon the design and installation of electrical apparatus for shop equipment. To this end they have retained the well-known firm of Dodge & Day, modernizing engineers, of Philadelphia, Pa. They place the services of this firm at the disposal of their customers, giving them gratuitously the benefit of its wide experience and data. The experience of the electrical engineer alone does not fully cover the numerous factors that are met in these days in the dividend-making management of machine shops. While the economies that may be effected by electric drive are conceded by all, the actual savings accomplished depend entirely upon the intelligence with which the apparatus is selected, installed and used. The advice and recommendations about which the Crocker-Wheeler Company's customers may consult Messrs. Dodge & Day need not be confined to electrical details, but may include all problems of shop equipment and management.

—Mackenzie, Quarrier & Ferguson, Inc., of 114-118 Liberty St., New York, have effected an arrangement with the Shepherd Engineering Company, of Franklin, Pa., whereby they will represent them as sales agents for the Shepherd vertical automatic steam engines. These engines are built in all sizes up to 1,500 horse power, and in simple, steeple, and cross-compound, single-valve and four-valve types. In the field of horizontal engines, Mackenzie, Quarrier & Ferguson will continue to offer the products of the Harrisburg Foundry and Machine Works, but there are many instances where the limitations of space and other conditions make the selection of a vertical engine desirable or necessary.

—The Cleveland, Cincinnati, Chicago & St. Louis Railway, popularly known as the "Big Four Route," has an interesting exhibit at the St. Louis Fair, a striking feature of which is a turntable in operation, with an express locomotive of the largest size crossing it.

—The Institution of Mechanical Engineers of Great Britain, about the time of its joint meeting in Chicago with the American Society of Mechanical Engineers, in response to an invitation of President Warren of the Allis-Chalmers Co., spent a day at the famous Allis engine works near Milwaukee, a visit which was one of the most pleasant and interesting experiences of the members of the Institution.

—The Brown Corliss Engine Company have recently increased their working capital by $150,000, which will put them in a position to carry on some of the largest work on the market. The Brown Corliss Engine Co. are building an up-to-date engine in every respect, and have one of the most modern shops in the country, and with the increased capitalization will be able to increase their business very materially.

—The Chicago office of the Nernst Lamp Company, in charge of A. E Fleming as district manager, has been removed from 638 National Life Building. La Salle Street, to 99 East Lake Street. The new offices are larger and better equipped in every way to care for the increasing business of the company in this locality.

—Manning, Maxwell & Moore have recently been awarded the entire contract for the tools and machinery for the railway shops of the Southern Pacific Company and its branch lines, including shops at the following points: The new shop at Reno, Nev., and additions to the shops at Sacramento, Cal.; San Francisco, Cal.; Newark, Cal.; San Luis Obispo, Cal.; Los Angeles, Cal.; Oakland, Cal.; Colton, Cal.; Dunsmuir, Cal.; Fresno, Cal.; Bakersfield, Cal.; Mojave, Cal.; Ogden, Utah; El Paso, Texas; Algiers, La.; Houston, Texas; Guaymas, Mexico, and Tucson, Ariz. This is said to be the largest single machine tool order that has been placed in this country for many years. The tools are all of the latest design, and many of them are being equipped with electric motors.

—Wyman & Gordon, of Worcester, Mass., and Cleveland, O., the manufacturers of drop forgings, have issued a new number of their series of booklets, containing short stories of engineers. This one is devoted to Kristofer Polhem, a famous Swedish engineer of the 17th and 18th centuries.

—The New York Central & Hudson River Railroad, through its passenger department, has issued a new map of Asia and the Chinese Empire, in which Manchuria and the other territory forming the theatre of the Russo-Japanese war are shown on such a large scale that the reader can readily trace the movements of the forces of both nations. This map, which is No. 28 of The Four-Track Series, has gone to all parts of the earth, and copies of it will be sent to any address on receipt of five cents, by George H. Daniels, General Passenger Agent, New York Central & Hudson River Railroad, Grand Central Station, New York.

—The New York Continental Jewell Filtration Company, of New York, have recently sold filters to H. M. Flagler, Palm Beach, Fla.; The Spring Water Carbonating Co., Boston, Mass.; J. A. Roebling's Sons Co., Trenton, N. J.; New York Public Baths, 232 West 60th street, New York City; Paducah Water Co., Paducah, Ky., the city plant; Philadelphia Hospital, Philadelphia, for the laundry; York Manufacturing Co., York, Pa., for the ice plant; Wm. Campbell Wall Paper Co., Hackensack, N. J.; The Erben-Harding Co., Tacony, Pa., for textile mills; Walcott-Campbell Spinning Co., New York Mills, N. Y.; York Manufacturing Co., Saco., Maine, textile mills; Earl & Wilson, Troy, N. Y.; Biddeford & Saco Water Co., Biddeford, Me.; Hornellsville Water Works Co., Hornellsville, N. Y.; Elmira Water, Light & Railroad Co., Elmira, N. Y. In the last three cases the filters newly ordered constitute a large increase to the plant already installed.

—The Yale & Towne Manufacturing Co., of 9-13 Murray Street, New York, have a fine exhibit of their well-known chain blocks at the St. Louis World's Fair, where they are also showing their new electric hoist.

—An arrangement between Arthur Koppel and the Baldwin Locomotive Works has just been consummated by which Arthur Koppel will be in a position to furnish Baldwin locomotives of all classes and sizes for any gauge, narrow as well as standard, and for all kinds of motive power, steam, electric, or compressed air.

—The Engineering Company of America, of 74 Broadway, New York, which have heretofore been engaged in purely professional work, have now gone into the general engineering, construction and contracting business, in addition, and are prepared to undertake all kinds of general contracting work, and desire bids from sub-contractors on such work as they have in their office, which at the present time, includes electric railroad construction, water works, power-houses, refrigerating plants, buildings and other projects, details of which will be furnished on application.

—Allis-Chalmers-Bullock, Limited, announce that they have taken over the business and representation in Canada of the Bullock Electric Manufacturing Co., Canadian Bullock Electric Manufacturing Company, Limited, Allis-Chalmers Company, Ingersoll-Sergeant Drill Company, Lidgerwood Manufacturing Co., Wagner Electric Manufacturing Co., and Canadian Engineering Co., Limited. Their head office and works will be at Montreal, and they will have branch offices at Toronto, Winnipeg, Halifax, Vancouver, and Rossland. The new organization will operate in the closest relations to the American companies indicated, and will manufacture machinery identical in design and of the same high grade of material and workmanship.

—The Hendrick Mfg. Co., of Carbondale, Pa., one of the largest manufacturers in this country of perforated sheet metals, have concluded to open an office in New York in the Singer Building, 149 Broadway, corner of Liberty Street. Mr. C. J. Thompson, who has had a broad experience along mechanical lines, will be the resident manager, and will furnish estimates and quotations at short notice.

—The De La Vergne Refrigerating Machine Co., at the foot of East 138th street, New York, has changed its name to De La Vergne Machine Co.

—The Broderick & Bascom Rope Co., of St. Louis, have issued a complete and convenient vest-pocket map of the St. Louis Exposition, which will be mailed to inquirers on receipt of a two-cent stamp for postage.

—Harvard University offers a summer course in geological field work in Colorado, preceded by an excursion to the Grand Canyon and the Pacific Coast. The party taking this course, which will be conducted by Mr. Charles H. White, A. M., Instructor in Mining and Metallurgy, whose address is Rotch Building, Cambridge, Mass., will start from St. Louis on August 15th, and will return there toward the end of September.

NEW CATALOGUES AND TRADE PUBLICATIONS

These catalogues may be had free of charge on application to the firms issuing them. Please mention The Engineering Magazine when you write.

Air Compressors.

Catalogue No. 35, containing illustrations and descriptions of air compressors for all capacities and all duties, of the straight-line and duplex types, simple and compound, with tables and useful information, and a view of the new works at Phillipsburg, N. J. 7 by 10 in.; pp. 71. The Ingersoll-Sergeant Drill Co., 26 Cortlandt St., New York.

Catalogue, containing illustrations and descriptions of Franklin air compressors of various types and many of their parts and accessories, including intercoolers and air receivers, with directions for the installation, adjustment and care of compressors, tables of pneumatic data and other useful information. 9 by 6 in.; pp. 72. Chicago Pneumatic Tool Co., Fisher Building, Chicago.

Bulletin No. 350, containing descriptions and illustrations of stationary and portable motor-driven air compressors for continuous and intermittent service on electric railways and in other places, with diagrams and tables. 9 by 6 in.; pp. 12. National Electric Company, Milwaukee.

Miniature catalogue, illustrating and describing some of the Rand standard types of air and gas compressors, with references to rock drills, pneumatic tools and other Rand products. 6 by 3½ in.; pp. 20. Rand Drill Co., 128 Broadway, New York.

Assayers' Appliances.

Booklets and flyer, illustrating and describing power gyratory muller, disc pulverizer, radial furnaces, "coronet" rolls and other labor-saving appliances for chemists and assayers. F. W. Braun Co., Los Angeles, Cal.

Ball Bearings.

Catalogue giving descriptions and illustrations of the Reid thrust and radial ball bearings in different styles and applied in various ways, with tables and other useful information about balls. 6 by 4½ in.; pp. 47. American Ball Co., Providence, R. I.

Calipers and Dividers.

Booklet containing illustrations, descriptions and prices of toolmakers' calipers and dividers, new in design and possessing many valuable features. 6 by 3½ in.; pp. 7. Brown & Sharpe Mfg. Co., Providence, R. I.

Contractors' Machinery.

Catalogue containing illustrations and descriptions of boilers, engines, pumps, derrick fittings, dump cars, blocks, rock drills, and many other tools, machinery and supplies for all forms of construction work. 9¾ by 7 in.; pp. 254. Harold L. Bond Company, Boston.

Cranes.

A package of sixteen cards, with illustrations and descriptions, in simple, non-technical language, of electric traveling cranes, cantilever cranes, gantry cranes, locomotive and wagon-truck cranes, crabs and winches, unloading machines and other kinds of cranes and hoisting machinery. 5½ by 3¼ in. The Brown Hoisting Machinery Co., Cleveland.

Electric Apparatus.

Illustrated bulletins Nos. 1001 to 1010, inclusive, devoted, respectively, to controllers, resistance units; brakes; solenoids and electro-magnets; fittings; lifting magnets; magnetic clutches; improved motor drive for planers; type "MT" controller; and magnetic switches. 7 by 5 in. The Electric Controller and Supply Company, Cleveland.

Electric Fans.

"The Standard" Products Book, containing several circulars, with illustrations and descriptions of desk, bracket and other styles of electric fans, and of electric motors and their applications. 10 by 8 in. The Robbins & Myers Co., Springfield, O.

Electric Machines.

Bulletin No. 1026, describing and illustrating types "H" and "HI" multipolar electric motors and generators, of open construction, and arranged for belt connection, and showing some of their applications in power houses and for driving machinery, with tables of ratings and dimensions. 9 by 6 in.; pp. 20. The Bullock Electric Mfg. Co., Cincinnati.

Electric Motors.

Bulletin No. 219, illustrating and describing "round-type," enclosed, direct-current motors and their application to machine driving, hoisting, pumping and various other purposes, with table of dimensions. 10½ by 8 in.; pp. 16. Sprague Electric Company, 527 W. 34th St., New York.

Electric Works.

Tastefully decorated pamphlet describing the works of the Westinghouse Electric & Manufacturing Co., their industrial and sociological aspect, and some of the remarkable apparatus produced there, fully illustrated from photographs. 9½ by 7½ in.; pp. 44. Westinghouse Electric & Manufacturing Co., Pittsburg.

Feed-Water Heaters.

Bulletin B 68, with illustrated description of the Blake-Knowles multi-current feed-water heater, in which the heat-transmitting surfaces and the direction of the currents of water and steam are so designed as to greatly increase the efficiency. 9 by 6 in.; pp. 4. International Steam Pump Co., 114-118 Liberty St., New York.

Hose Couplings.

Pamphlet No. 5, illustrating and describing the "Quick as Wink" coupler for air, steam or gas hose, used with pneumatic tools and for other purposes, which has tight joints that swivel, and can be very quickly and conveniently applied and removed. 9 by 6 in.; pp. 12. Also, pamphlet No. 6, showing the application of this coupler to water hose. 9 by 6 in.; pp. 12. The W. J. Clark Company, Salem, O.

Locomotives.

Supplement No. 2 to catalogue No. 77, with illustrations of many styles of Baldwin locomotives for narrow, as well as standard, gauges. 10 by 8 in.; pp. 6. Arthur Koppel, 66-68 Broad St., New York.

Machine Tools.

Catalogue, containing illustrated descriptions of automatic chucking and turning machines, lever chuck, double-turret lathes, manufacturing lathes, universal shaping machines, and other machine tools. 6 by 9 in.; pp. 52. Potter & Johnston Machine Co., Pawtucket, R. I.

Portland Cement.

Pamphlet, containing description of "Dragon" Portland cement and its manufacture, directions for testing, results of tests, uses for which it is adapted, list of users, information about mortar, cement and concrete, testimonials and other matter. 8 by 5 in.; pp. 81. The Lawrence Cement Co., 1 Broadway, New York.

Pumps.

Catalogue No. 16, containing illustrations and brief description of special high-duty and mine pumps, with table giving code words, dimensions and prices. 3½ by 6 in.; pp. 6. The National Steam Pump Co., Upper Sandusky, O.

Reinforced Concrete.

Booklet entitled "Twisted Steel," showing how the Ransome twisted bars are used in all kinds of reinforced-concrete construction, with illustrations, diagrams and formulae. 6 by 3½ in.; pp. 20. Ransome Concrete Machinery Co., 11 Broadway, New York.

Renold Chain.

Booklet No. 39, 1904, containing illustrations and descriptions of the Renold Silent Chain Gear, and its application to many kinds of power transmission. In its latest style, the wear is transferred from the hole of the link to a case-hardened bushing, so that the chain is practically non-elongating. 7½ by 3¾ in.; pp. 34. The Link-Belt Engineering Co., Nicetown, Philadelphia.

Riveters.

Catalogue No. 3, containing descriptions and illustrations of portable and stationary pneumatic compression yoke riveters for bridge, boiler, tank, shipbuilding, and all other structural iron and steel construction. 9 by 6 in.; pp. 16. Hanna Engineering Works, 820 Elston Ave., Chicago.

Seamless Pipe.

Large pamphlet, with well illustrated description of the Bartlett-Kent process for rolling seamless steel pipe, and an account of the organization of a company and the laying out of a plant for its manufacture. 13 by 10 in.; pp. 16. Seamless Rolled Steel Pipe Co., Chester, Pa.

Steam Engines.

Large pamphlet, with half-tone illustrations, line drawings and description of the new Hamilton-Corliss vertical cross-compound steam engine and its details. 12 by 9¼ in.; pp. 16. The Hooven, Owens, Rentschler Co., Hamilton, O.

Catalogue, containing illustrations and descriptions of Fulton-Corliss steam engines, in various styles, and their parts, with views of plants where they are installed, directions for the adjustment of Corliss valve gear, tables of indicated horse power of compound engines, and other useful information. 6¾ by 10½ in.; pp. 61. Fulton Iron Works, St. Louis.

Series E-1 catalogue, with descriptions and illustrations of enclosed and automatic steam engines, direct connected and belted, and their parts and accessories. These engines are built in accordance with the standards of the American Society of Mechanical Engineers and the American Institute of Electrical Engineers for direct-connected generating sets, and possess many useful and valuable features. 6 by 9 in.; pp. 26. Chandler & Taylor Company, Indidanapolis.

Steel Cars.

Cloth-bound book, with descriptions of hopper, gondola, and other styles of steel cars made with structural shapes, illustrated from photographs of cars in use by some of the leading railroads. 6 by 9 in.; pp. 34. Cambria Steel Co., Philadelphia.

Storage Batteries.

Bulletins Nos. 82 and 83, devoted respectively to "The Storage Battery in Small Central Stations," by J. M. S. Waring, reprinted from *The Central Station*, and to "The Chloride Accumulator in Connection with the Exciter Circuits of Large Alternating-Current Generating Stations," with illustrations. 10½ by 8 in.; pp 4 and 6. The Electric Storage Battery Co., Philadelphia.

Transformers.

Pamphlet No. 9127, entitled "Fifteen Years' Experience in Transformer Practice," giving an illustrated account of the development in the manufacture of transformers by the General Electric Company, culminating in the improved designs of their Type H core transformer. 7¾ by 5¼ in.; pp. 16. General Electric Company, Schenectady, N. Y.

Water Wheels.

Bulletin No. 5, containing illustrations and descriptions of the Doble tangential water wheels and some of their parts and accessories, including ellipsoidal buckets, needle regulating nozzles, wheel housings, and ring-oiling bearings, with useful hydraulic tables. 4½ by 7 in.; pp. 46. Abner Doble Company, San Francisco.

NEWS SUPPLEMENT

The Engineering Magazine—August, 1904

Coming Society Meetings.

AMERICAN BOILER MANUFACTURERS' ASSOCIATION. Sec.: J. D. Farasey, Cleveland. Next meeting, Oct. 4-6, at St. Louis.

AMERICAN ELECTROCHEMICAL SOCIETY. Sec.: S. S. Stadler, 39 S. 10th St., Philadelphia. Next meeting, Sept. 12-17, at St. Louis.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS. Sec.: Ralph W. Pope, 95 Liberty St., New York. Joint convention with Institution of Electrical Engineers, Sept. 14-17, St. Louis.

AMERICAN INSTITUTE OF MINING ENGINEERS. Sec.: R. W. Raymond, 99 John St., New York. Annual convention, Sept. 14-21, at Duluth, Minn., and Houghton, Mich.

AMERICAN INSTITUTE, POLYTECHNIC SECTION. Sec.: George Whitefield, Jr., 19 W. 44th St., New York. Meetings on first and third Tuesdays of each month, from October to May, inclusive.

AMERICAN RAILWAY ASSOCIATION. Sec.: W. F. Allen, 24 Park Place, New York. Next meeting, Oct. 26, at Philadelphia.

AMERICAN RAILWAY MECHANICAL AND ELECTRICAL ASSOCIATION. Sec.: Walter Mower, Detroit. Annual meeting, Oct. 10-15, at St. Louis.

AMERICAN SOCIETY OF CIVIL ENGINEERS. Sec.: C. W. Hunt, 220 W. 57th St., New York. Regular meetings, first and third Wednesdays of each month, except July and August.

AMERICAN SOCIETY OF MUNICIPAL IMPROVEMENTS. Sec.: Geo. W. Tillson, Municipal Building, Brooklyn, N. Y. Annual meeting, Oct. 4, at St. Louis.

AMERICAN STREET RAILWAY ASSOCIATION. Sec.: T. C. Penington, 2020 State St., Chicago. Annual meeting, Oct. 10-15, at St. Louis.

ASSOCIATION OF EDISON ILLUMINATING COMPANIES. Sec.: W. S. Barstow, New York and Portland, Ore. Next meeting, Aug 30-Sept. 1., New Castle, N. H.

ASSOCIATION OF RAILWAY SUPERINTENDENTS OF BRIDGES AND BUILDINGS. Sec.: S. F. Patterson, Concord, N. H. Annual convention, Oct. 18-20, at Chicago.

BOSTON SOCIETY OF CIVIL ENGINEERS. Sec.: S. E. Tinkham, 715 Tremont Temple. Regular meetings on third Wednesday of each month, except July and August.

BROOKLYN ENGINEERS' CLUB. Sec.: J. Strachan, 191 Montague St. Regular meetings on second Thursday of each month.

CANADIAN RAILWAY CLUB. Sec.: W. H. Rosevear, Jr., Montreal. Regular meetings on first Tuesday of each month, except June, July and August.

CANADIAN SOCIETY OF CIVIL ENGINEERS. Sec.: Prof. C. H. McLeod, 877 Dorchester St., Montreal. Meetings on different Thursdays, from October to May.

CENTRAL RAILWAY CLUB. Sec.: Harry D. Vought, 62 Liberty St., New York. Regular meetings on second Friday of January, March, May, September and November, Hotel Iroquois, Buffalo.

CHICAGO ELECTRICAL ASSOCIATION. Sec.: W. B. Hale, Monadnock Building. Regular meetings on first and third Fridays of each month, from October to May.

CIVIL ENGINEERS' CLUB OF CLEVELAND. Sec.: Joseph C. Beardsley, 689 The Arcade. Regular meetings on second and fourth Tuesdays of each month.

CIVIL ENGINEERS' SOCIETY OF ST. PAUL. Sec.: G. S. Edmondstone. Regular meetings on second Monday of each month.

CONNECTICUT STATE STREET RAILWAY ASSOCIATION. Sec.: E. W. Poole, Bridgeport. Annual meeting in November.

ENGINEERING ASSOCIATION OF THE SOUTH. Sec.: Robt. L. Lund, 2102 Hayes St., Nashville, Tenn. Regular meetings on second Thursday of each month at the Berry Block. Convention at St. Louis.

ENGINEERS' CLUB OF CHICAGO. Sec.: B. W. Thurtell, 1223 New York Life Building. Regular meetings on first and third Tuesdays of each month.

ENGINEERS' CLUB OF CINCINNATI. Sec.: J. F. Wilson, P. O. Box 333. Regular meeting on third Thursday of each month, except July and August.

ENGINEERS' CLUB OF COLUMBUS (OHIO). Sec.: H. M. Gates, 5½ West Broad St. Regular meetings on third Saturday of April, May, June and September, and on first and third Saturdays from October to March, inclusive.

ENGINEERS' CLUB OF MINNEAPOLIS. Sec.: Jas. B. Gilman, American Bridge Co. Regular meetings on third Monday of each month, except July and August.

ENGINEERS' CLUB OF PHILADELPHIA. Sec.: J. O. Clarke, 1122 Girard St. Regular meetings on first and third Saturdays of each month, except July and August.

ENGINEERS' CLUB OF ST. LOUIS. Sec.: H. J. Pfeifer, 920 Rialto Bldg. Regular meetings on first and third Wednesdays of each month.

Engineers' Society of Western New York. Sec.: H. B. Alverson, 533 Ellicott Square, Buffalo. Regular meetings on first Tuesday of each month, except July and August.

Engineers' Society of Western Pennsylvania. Sec.: Chas. W. Ridinger, 410 Penn Ave., Pittsburg. Regular meetings on third Tuesday of each month.

Franklin Institute. Sec.: Dr. Wm. H. Wahl, 15 South 7th St., Philadelphia. General meetings on third Wednesday of each month, except July and August.

Honolulu Engineering Association. Sec.: G. F. Bush, Honolulu, Hawaii.

Independent Telephone Association of the United States of America. Sec.: Frank G. Jones, 48 W. Jackson Boulevard, Chicago. Next meeting, Sept., at St. Louis.

Indiana Public Utilities Association. Sec.: A. M. Barron, South Bend, Ind. Next meeting, Oct. 18, at Indianapolis.

Institution of Electrical Engineers. Sec.: G. C. Lloyd, 92 Victoria St., Westminster, London. Joint convention with Am. Inst. of Elect. Engrs., Sept. 12-17, at St. Louis.

International Association of Municipal Electricians. Sec.: Frank P. Foster, Corning, N. Y. Meeting, Sept. 13-14, at St. Louis.

International Electrical Congress. Sec.: Dr. A. E. Kennelly, Harvard University, Cambridge, Mass. Meeting, Sept. 12-17, at St. Louis.

International Engineering Congress. Sec.: Charles Warren Hunt, 220 W. 57th St., New York. Meeting, Oct. 3-8, at St. Louis.

Iowa Railway Club. Sec.: P. B. Vermillion, Des Moines. Iowa. Regular meetings on third Tuesday of each month.

Iron and Steel Institute. Sec.: B. H. Brough, 28 Victoria St., London, S. W. Annual meeting, Oct. 24-26, at New York.

Louisiana Engineering Society. Sec.: G. W. Lawes, 806 Gravier St., New Orleans. Regular meetings on second Monday of each month.

Massachusetts Street Railway Association. Sec.: Charles S. Clark, 70 Kilby St., Boston. Meetings second Wednesday of each month, except July and August.

Montana Society of Engineers. Sec.: Clinton H. Moore, Butte, Mont. Regular meetings on second Saturday in each month.

National Electrical Contractors' Association of the United States. Sec.: W. H. Morton, Utica, N. Y. Annual convention, Sept. 14-16, at St. Louis.

National Electric Light Association. Sec.: Ernest H. Davis, 136 Liberty St., New York. Meeting, Sept., at St. Louis.

New England Railroad Club. Sec.: Edw. L. Janes, Back Bay P. O., Boston. Regular meetings, second Tuesday in each month, except June, July, August and September, at Pierce Hall, Copley Square.

New England Street Railway Club. Sec.: J. H. Neal, 101 Milk St., Boston. Meetings on last Thursday of each month.

New York Electrical Society. Sec.: Geo. H. Guy, 114 Liberty St., New York. Meetings monthly. at the American Institute, 19 W. 44th St.

New York Railroad Club. Sec.: Harry D. Vought, 62 Liberty St., New York. Regular meetings on third Friday of each month, except June, July and August, at Carnegie Hall, 154 W. 57th St., New York.

New York Street Railway Association. Sec.: W. W. Cole, Elmira. Annual meeting, Oct. 11 and 12, at Utica.

Northwestern Electrical Association. Sec.: Thos. R. Mercein, Milwaukee. Annual convention, Sept., at St. Louis.

North-West Railway Club. Sec.: T. W. Flannagan, Minenapolis, Minn. Regular meetings on first Tuesday after second Monday of each month, except June, July and August, alternating between Minneapolis and St. Paul.

Ohio Electric Light Association. Sec.: D. L. Gaskill, Greenville. Next meeting, Aug. 16-18, at Sandusky.

Ohio Society of Mechanical, Electrical and Steam Engineers. Sec.: Corwin J. Miller, Canton. Next meeting, Nov. 18, at Canton.

Pacific Coast Electrical Transmission Association. Sec.: Geo. P. Low, 237 Cherry St., San Francisco. Annual convention, third Tuesday in June. Intermediate meetings subject to call.

Pacific Coast Railway Club. Sec.: C. C. Borton, West Oakland, Cal. Regular meetings on third Saturday of each month at San Francisco and other cities.

Pacific Northwest Society of Engineers. Sec.: Prof. M. Roberts, Seattle, Wash. Meetings monthly in Chamber of Commerce rooms, Seattle.

Railway Club of Pittsburg. Sec.: J. D. Conway, P. & L. E. R. R., Pittsburg, Pa. Regular meetings on fourth Friday of each month, except June, July and August, at Hotel Henry.

Railway Signal Association. Sec.: B. B. Adams, 83 Fulton St., New York. Regular meetings on second Tuesdays of January, March, May, Sept. and Nov. Next meeting, Sept. 13, at Chicago. Annual meeting, Oct. 11, at St. Louis.

Railway Water Supply Association. Sec.: F. W. Hayden, Glencoe, Minn. Meetings on first Sunday of each quarter at Alexander Hall, South Minneapolis, Minn.

RICHMOND RAILWAY CLUB. Sec.: F. O. Robinson, 8th & Main Sts., Richmond, Va. Regular meetings on second Thursday of each month, except June, July and August.

ROADMASTERS' AND MAINTENANCE-OF-WAY ASSOCIATION. Sec.: C. E. Jones, Beardstown, Ill. Annual meeting, Sept. 13-15, at St. Louis.

ROCKY MOUNTAIN RAILWAY CLUB. Sec.: M. M. Currier, Colorado City. Regular meetings on second Tuesday of each month, except June, July and August, at Union Depot, Denver.

ST. LOUIS RAILWAY CLUB. Sec.: E. A. Chenery, Union Station, St. Louis. Regular meetings on second Friday of each month, except July and August.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION. Sec.: C. A. Waldo, Purdue University, Lafayette, Ind. Annual convention, Sept. 1-3, at St. Louis.

SOUTHERN AND SOUTHWESTERN RAILWAY CLUB. Sec.: W. A. Love, Atlanta, Ga. Regular meetings on third Thursday of Jan., April, Aug. and Nov., at Atlanta.

TECHNICAL SOCIETY OF THE PACIFIC COAST. Sec.: Otto von Geldern, 31 Post St., San Francisco. Regular meetings on first Friday of each month.

TEXAS RAILWAY CLUB. Sec.: T. H. Osborne, Pine Bluff, Ark. Regular meetings on third Monday of April and September.

TOLEDO SOCIETY OF ENGINEERS. Sec.: L. M. Gram, 519 Gardner Building, Toledo, O. Meetings on third Friday of each month in National Union Building.

TRAVELING ENGINEERS' ASSOCIATION. Sec.: W. O. Thompson, Oswego, N. Y. Next meeting, Sept. 13, at Chicago.

VERMONT ELECTRICAL ASSOCIATION. Sec.: C. C. Wells, Middlebury. Next meeting, Sept. 21 and 22, at Montpelier.

WESTERN RAILWAY CLUB. Sec.: J. W. Taylor, 667 Rookery, Chicago. Meetings on third Tuesday of each month, except June, July and August, Auditorium Hotel, Chicago.

WESTERN SOCIETY OF ENGINEERS. Sec.: J. H. Warder, Monadnock Block, Chicago. Regular meetings on first Wednesday and extra meetings on third Wednesday of each month, except July and August.

Personal.

—Dr. Edward Weston, the electrical engineer and inventor, and president of the Weston Electrical Instrument Co., had the degree of Doctor of Science conferred upon him by Stevens Institute of Technology, at its Commencement exercises in June.

—Mr. Gardner S. Williams, M. Am. Soc. C. E. and Professor of Experimental Hydraulics in charge of the Hydraulic Laboratory of Cornell University, has been appointed to the chair in engineering at the University of Michigan, made vacant by the death last fall of Prof. Chas. E. Greene, M. Am. Soc. C. E. This appointment indicates a development of work in the Michigan engineering course along hydraulic and sanitary lines for which, in connection with the laboratories in the new Engineering Building, there are afforded excellent opportunities

—Dr. Schuyler Skaats Wheeler, president of the Crocker-Wheeler Company, sailed recently for England, where he has planned a coaching trip, but as he went on an automobile tour through the south of France early this spring, and returned with the American patent rights of the world-renowned electrical firm of Brown, Boveri & Cie., of Baden, Switzerland, his holiday trips attract a great deal of attention in the electrical business world.

—Mr. Louis Terven, E. E. (University of Wisconsin), has recently been appointed chief electrician of the Nernst Lamp Company, Pittsburg, Pa. Mr. Terven was for some time electrician of the United States Navy Yard, Port Royal, S. C., which position he resigned to enter the experimental laboratory of the Nernst Lamp Company.

—Mr. Fred Harris has severed his connection with the Rand Drill Company, of which he was formerly sales agent in Butte and Salt Lake City.

—Mr. A. L. Waterbury, who was at one time first vice-president and general manager of the Citizens Telephone Co., of Houston, Tex., has accepted a position as general manager of the sales department of the American Conduit Co. Mr. Waterbury will have his headquarters at the Chicago office of this company, 1005-6 Manhattan Building.

—Mr. Walter H. Whiteside, formerly manager of the detail and supply department of the Westinghouse Electric & Manufacturing Company, and, at the same time, general manager of the Sawyer-Man Electric Co., has been appointed general manager of sales for all departments of the Allis-Chalmers Co., including, of course, the Bullock Electric Manufacturing Co., which has become the electrical department of the Allis-Chalmers Co

Industrial Notes.

The Crocker-Wheeler Company, of Ampere, N. J., by arrangement with the celebrated electrical engineers, Brown, Boveri & Cie., of Baden, Switzerland, have secured their alternating-current designs, patents and rights to manufacture in America, and have retained them as consulting engineers. The Crocker-Wheeler Company are now putting on the market alternating current generators, transformers and accessories of the most perfect design and construction, adapted to American practice, and have already closed a contract for a 200-K. W., 60-cycle, 440-volt, alternating-current generator, for the Atlanta plant of the Proctor & Gamble Co., Cincinnati, and are figuring on an actively increasing number of alternating propositions.

The Grand Trunk Railway System have included in the large list of summer and winter resorts which they are bringing before the public, the sanitarium at St. Catharines, Ont., a retreat for rest and recuperation. A mineral spring from which the water flows and which is used for bathing and massage purposes at this establishment, was discovered years ago, and has been the means of attracting hundreds of the best class of people from the south to enjoy the benefits derived from bathing in it. It is only during the last few years that a commodious sanitarium has been established at this point. combining rest-cure and family hotel. Copies of a neat little booklet giving further particulars may be had by applying to G. T. Bell, general passenger and ticket agent, Grand Trunk Railway System, Montreal, Quebec.

The American Institute of Electrical Engineers has extended an invitation to the Institution of Electrical Engineers of Great Britain to visit the United States in September and to hold a joint meeting in St. Louis in connection with the International Electrical Congress. This invitation has been accepted by the Institution of Electrical Engineers, and a large number of its members, many accompanied by ladies. are expected to arrive in this country by the White Star steamship "Republic" reaching Boston, September 2d. A general invitation has also been extended to European electrical engineering societies to join in a circular tour, visiting principal cities and important industrial centres, organized by the American Institute of Electrical Engineers for the reception and entertainment of its guests and visiting electrical engineers. A number of acceptances have already been received from European electrical engineers and a large delegation of the Associazione Elettrotecnica Italiana, with a number of ladies, is expected to arrive in New York, August 24th and the subsequent days up to September 2d, when they will proceed to Boston, joining the main party there on September 3d. A General Reception Committee and a Committee on Transportation and Arrangements have been appointed by the President of the American Institute of Electrical Engineers and Local Reception Committees have been appointed in the cities which are included in the itinerary of the special circular tour, which will comprise Boston, New York, Schenectady, Montreal, Niagara Falls, Chicago, St. Louis, Pittsburg, Washington and Philadelphia. The Chairman of the General Reception Committee is Mr. J. W. Lieb, Jr., 55 Duane St., New York, and the Chairman of the Committee on Transportation and Arrangements is Mr. E. H. Mullin, 44 Broad St., New York. Foreign electrical engineering societies who may take part in the tour represented by a delegation of their membership, and foreign electrical engineers who desire to accompany the party, are requested to make application at once, giving their names, address and the electrical engineering society with which they are affiliated and from whom they come accredited, and to state when they expect to arrive in the United States, and at what port, to Mr. Ralph W. Pope, Secretary, American Institute of Electrical Engineers, 95 Liberty St., New York City, to whom all communications respecting the circular tour should be addressed. To him also should be addressed all letters, telegrams, etc., for those participating in the tour and while they are en route, and his office will forward them to the nearest stopping place.

—The Allis-Chalmers Company have a power exhibit in the center of Machinery Hall at the St. Louis World's Fair, which includes a 5,000 horse-power Allis-Chalmers engine and Bullock electric generator supplying current for the decorative lighting of the buildings and grounds. At this exhibit visitors will find not only a comfortable resting place, but also writing tables and stationery, attendants who will receive and forward mail and telegrams, who will check parcels and wraps and who will provide ice water, all free of charge. Machinery Hall is open until eleven o'clock in the evening.

Dodge & Day, Modernizing Engineers, Philadelphia, in conjunction with Ballinger & Perrot, Architects, are proceeding with the work of re-building and extending the plant of the Victor Talking Machine Company, Camden, N. J. The shops are to be electrically operated and motor drives used throughout. The work is to be completed within six months from date. This is the same concern that suffered a severe damage by fire a short time since.

Arthur Koppel, the manufacturer of narrow and standard gauge railway materials, of 66-68 Broad St., New York, has an exhibition of track switches, turntables, cars of various styles, etc., in the building of Mining and Metallurgy, Block 20, Assignment 10, at the St. Louis Exposition.

The Iron and Steel Institute of Great Britain, of which Mr. Andrew Carnegie is President, will hold its annual meeting in New York on October 24th, 25th and 26th. After this meeting the members of the Institute and their friends will visit Philadelphia, Washington, Pittsburg, Cleveland, Buffalo and Niagara Falls, and those who desire to do so will extend their trip to St. Louis, for the Exposition, returning to New York in time for the steamer sailing Nov. 12th. For the reception of the Institute an influential committee has been formed in the United States, Mr. John Fritz being the President; Mr. Charles Kirchhof, Chairman of the Executive Committee; Mr. Robert E. Jennings, Treasurer, and Mr. Theodore Dwight, 99 John St., New York, Secretary.

The Pittsburgh Gage & Supply Co., of Pittsburg, has installed continuous oiling systems using the White Star Oil Filter at the Carnegie Steel Co., Homestead, Pa.; the Nashville Railway & Lighting Co., Nashville, Tenn.; the Allegheny City Lighting Station, Allegheny, Pa.; the Henry Phipps Power Plant, Pittsburg, Pa., and the Harris Steam Engine Co., Providence, R. I.

The conference committee representing the American Society of Mechanical Engineers, the American Institute of Mining Engineers, the American Institute of Electrical Engineers and the Engineers' Club, which is administering Mr. Carnegie's gift of $1,500,000 for the erection of the United Engineering Building and the house of the Engineers' Club, has selected the architects for these structures. It was the expressed wish of Mr. Carnegie that the competition should be a mixed one, so that in addition to selecting six competent architects, the committee threw the work open to all comers and provided a prize scheme to compensate the best competitors in the open class. The committee received 26 complete sets of competitive plans for the two buildings, comprising over 500 drawings, and, with the assistance of Prof. W. R. Ware as expert adviser, has spent a good deal of time in the consideration of these designs, all of which, of course, were submitted anonymously. The conclusions now reached are unanimous. The successful competitor for the United Engineering Building is Mr. Herbert D. Hale, of Boston, a competitor in the open class, with Mr. Henry G. Morse, of New York, as associate architect. Mr. Hale is a grandson of Edward Everett Hale and has done a large amount of public architecture in New England and has constructed some Carnegie libraries, besides doing a very considerable amount of work for the New York Shipbuilding Company. The successful competitors for the Engineers' Club are Whitfield & King, of New York, who were among the selected architects; they have done a large amount of work in New York City and on various Carnegie libraries, and were also associated in work on the buildings of the Pan-American Exposition. The designs of this firm were also among those favorably considered for the United Engineering Building, awarded to Mr. Hale. The successful competitors in the open class for four equal prizes of $400 each, in addition to Mr. Hale, are: Trowbridge & Livingston, of New York; Frank C. Roberts & Co., with Edgar V. Seeler, Philadelphia, associate; and Allen & Collins, of Boston. It is interesting to note that a very large proportion of the competitive designs came from Boston and that the largest prize, namely, the award for the United Engineering Building, as well as one of the smaller money prizes, has gone to that city. As has already been told, the two buildings will require for construction from $1,100,000 to $1,200,000. The United Engineering Building will occupy land 125 feet front by 100 feet on West 39th St., while the Engineers' Club building, with a frontage of 50 feet and a depth of 100 feet, will face on Bryant Park and the new Public Library. The United Engineering Building, aside from quarters for the American Society of Mechanical Engineers, the American Institute of Electrical Engineers and the American Institute of Mining Engineers, as well as other societies enabled to participate in the accommodations, will have several fine auditoriums and a magnificent library. The Club building will be about 11½ stories high, with the usual accommodations of a club and some 60 or 70 bedrooms for members. The work of tearing down the old buildings and the construction of the new is to be pushed vigorously and will begin forthwith.

—C. A. Hammel, of Los Angeles, Cal., the patentee and manufacturer of the Hammel oil burner, has published the results of some tests made with these burners on locomotives in regular service on the San Pedro, Los Angeles and Salt Lake Railroad, which were very satisfactory.

—The Bullock Electric Mfg. Co., have removed their New York offices to the Empire Building, 71 Broadway, with E. W. Goldschmidt, the district manager, in charge.

—The Shepherd Engineering Co., of Franklin, Pa., the designers and builders of Shepherd steam engines, have established branch offices, in Chicago, Philadelphia and Boston. The Philadelphia office is in the Witherspoon Building, with Mr. Edward D. Sidman in charge, and the Boston office is situated in the new Oliver Building at Oliver and Milk Streets, in charge of Mr. W. N. Clifford.

—The National-Acme Manufacturing Company, of Cleveland, Ohio, announce the opening of their New York office, R. A. Scranton, manager, in the St. Paul Building, 220 Broadway, where they will be pleased to receive inquiries and orders for "Acme Automatic" multiple-spindle screw machines, "Acme Screw Slotters," semi-automatic, cap screws, set screws, special screws, and parts milled from rod or bar.

—The Niagara Machine & Tool Works, of Buffalo, N. Y., the manufacturers of tools for sheet metals, have an interesting exhibit in the Machinery Building, at the World's Fair, St. Louis, including automatic can machinery, presses, shears, tinners' tools, and other machines.

—The International Electrical Congress will convene at St. Louis, beginning at 9:30 A. M., on Monday, September 12, 1904. The opening ceremonies of the Congress will be held in the Music Hall of the Coliseum, at Olive and Thirteenth streets. The meetings of the eight sections will follow commencing at 11 A. M., in the section halls on the second floor of the Coliseum, the sections adjourning on Monday, at 1:30 P. M. On Tuesday, Thursday and Friday the sections will meet on the second floor of the Coliseum at 9 A. M., and will adjourn not later than 1 P. M. On Wednesday at 10 A. M., the Annual Convention of the American Institute of Electrical Engineers will be formally opened at Festival Hall in the grounds of the Louisiana Purchase Exposition, and the President of the Institute, Mr. Bion J. Arnold, will then deliver the annual address. Immediately afterward a topical discussion will follow between the Institution of Electrical Engineers of Great Britain and the American Institute of Electrical Engineers, the subject of which will be announced later. Arrangements are being made for holding a closing meeting of the International Congress and this will probably be held in one of the buildings in the grounds of the Exposition. The International Electrical Congress is held under the auspices of the Louisiana Purchase Exposition and the following bodies in America are co-operating in the holding of the Congress: The American Institute of Electrical Engineers, The American Electrochemical Society, American Physical Society, The National Electric Light Association, The Association of Edison Illuminating Companies, International Association of Municipal Electricians, The American Electro-Therapeutic Association. The fee for membership in the Congress is $5, which may be forwarded to either the Secretary, Dr. A. E. Kennelly, Harvard University, Cambridge, Mass., or the Treasurer, Mr. W. D. Weaver, 114 Liberty St., New York.

NEW CATALOGUES AND TRADE PUBLICATIONS

These catalogues may be had free of charge on application to the firms issuing them. Please mention The Engineering Magazine when you write.

Boilers.

Pamphlet, containing illustrations and descriptions of the McNaull patent economic safety water-tube boilers, in both horizontal and vertical types, and for both stationary and marine use, with views of many buildings and plants where they are installed. Also, table giving heights of chimneys and commercial horse power of boilers. 6 by 9 in.; pp. 48. W. D. McNaull, Toledo, O.

Cement.

Pamphlet, entitled "The Cement Age: The Many Uses and Increasing Demand for Plastic Materials," by R. W. Lesley, a reprint of a paper before the Engineers' Club of Philadelphia. 9 by 6 in.; pp. 8. American Cement Co., 22 S. 15th St., Philadelphia.

Centrifugal Pumps.

Pamphlet, with diagrams and description of the Brooks centrifugal pump, showing the reasons for its high efficiency. 9 by 6 in.; pp. 8. Wm. H. Cook & Co., Monadnock Building, Chicago.

Coal Pockets.

Booklet No. 38, 1904, with illustrations and descriptions of retail coal pockets and coal storage plants, and of coal handling machinery. 9 by 6 in.; pp. 32. The Link-Belt Engineering Company, Nicetown, Philadelphia.

Condenser.

Folder, illustrating and describing a saturating air surface condenser which condenses, at atmospheric pressure, the exhaust steam from the engines and other apparatus in the artificial ice plant of the Vanderslice-Lynds Mercantile Co., of Kansas City. 13½ by 5¾ in.; pp. 4. Atmospheric Condensation Co., Kansas City, Mo.

Crushing Machinery.

Catalogue, containing testimonials from users of Williams' crushing, pulverizing, granulating, shredding and grinding machinery, with illustrations of a few of these machines. 9 by 6 in.; pp. 120. The Williams Patent Crusher and Pulverizer Co., St. Louis.

Drills.

Catalogue, containing illustrations and descriptions and prices of rope-driven and electric portable drills, duplex and five-spindle boiler-shell drills, hand drills, and auxiliary appliances. 9 by 6 in.; pp. 44. Thos. H. Dallett Co., York St. and Sedgley Ave., Philadelphia.

Drop Forgings.

Catalogue, containing illustrations and descriptions of improved drop hammers, die shoes, with two die keys, automatic trips, drop boards, board guards, concrete foundations, trimming presses, heating furnaces, Lombard's patent lifting jacks, and other details of drop hammers, and appliances for making drop forgings. 10¼ by 7 in.; pp. 36. The Billings & Spencer Company, Hartford, Conn.

Electric Apparatus.

Several publications, including pamphlets on electric fan motors, lightning arresters, and the Curtis steam turbine; bulletins on cable-testing current transformers, sewing-machine motors and pocket instruments for direct or alternating current; and flyers, booklets and price lists devoted to various kinds of electric instruments and apparatus. General Electric Company, Schenectady, N. Y.

Electric Drill.

Special circular No. 48, illustrating and describing the Duntley air-cooled electric drill, fitted with feed screw and breast plate, and with a switch in the handle, made in various sizes and adapted to a great variety of work. 11 by 8½ in.; pp. 2. Chicago Pneumatic Tool Co., Fisher Building, Chicago.

Electric Generators.

Bulletin No. 47, entitled "The Power of the Intramural," containing illustrations and descriptions of the electric generating plant of the Intramural," containing illustrations and de-Fair, with a map of the exposition grounds. 10 by 7½ in.; pp. 12. Crocker-Wheeler Company, Ampère, N. J.

Electric Locomotives.

Bulletin No. 8, entitled "Electric Locomotives for Gathering Purposes," by C. E. Waxborn, containing descriptions and illustrations of types of these locomotives for use in coal mines. 10 by 8 in.; pp. 16. The Jeffrey Manufacturing Co., Columbus, O.

Fireproof Windows.

Folder, calling attention to the Lupton fireproof window, of original design and superior hollow sheet steel or copper construction, and glazed with wire glass. 12½ by 10 in.; pp. 2. David Lupton's Sons Company, Allegheny Ave., and Tulip St., Philadelphia.

Furnaces.

Catalogue, containing illustrations and descriptions of Stewart gas furnaces which burn any kind of gas and are adapted to a great variety of purposes, and also of flexible shafts, with some of their numerous applications. 7¾ by 10¾ in.; pp. 64. The Chicago Flexible Shaft Co., La Salle Ave. and Ontario St., Chicago.

Gas Producers.

Pamphlet, describing and illustrating a suction gas producer, showing its advantages, and comparing gas producer plants with other systems of power generation. 9 by 4 in; pp. 12. Baltimore Gas Machinery Co., Baltimore.

Graphite.

Pamphlets and booklets devoted to graphite in several forms and for various purposes, entitled "Graphite Afloat and Afield," "Graphite as a Lubricant," "Oil vs. Grease Lubrication," "Dixon's Graphite Cup Greases," "Dixon's Ticonderoga Graphite Grease," and "Slipping Belts," the last describing Dixon's traction belt dressing and leather preservative. Joseph Dixon Crucible Co., Jersey City, N. J.

Heaters.

Booklet, giving illustrations, dimensions, ratings and prices of Thatcher steam and hot water heaters, radiators and specialties. 6 by 3½ in.; pp. 24. Also, folder devoted to Thatcher heaters, ranges, and tubular warm air furnaces. 7 by 7 in.; pp. 6. Thatcher Furnace Co., 240 Water Street, New York.

Hobs.

Pamphlet containing a list of stock hobs, the tools for forming the teeth of worm gears, with dimensions and other data. 9¼ by 6 in.; pp. 8. R. D. Nuttall Company, Pittsburg.

Machine Tools.

Lousiana Purchase Exposition special number of the "Progress Reporter" for July, 1904, a pamphlet containing illustrations and descriptions of heavy axle and car wheel lathes, turret lathes, forge planers, milling machines, shaping machines, drills, boring mills, hydraulic riveters, steam hammers, cranes, Pratt & Whitney screw machines, turret lathes and small tools, and other machine tools shown at the St. Louis Fair. 12 by 9 in.; pp. 36. Niles-Bement-Pond Co., 136-138 Liberty St., New York.

Catalogue, containing illustrations, descriptions and prices of turret lathes, square-arbor lathes, valve-milling machines, ball machines, chucks, slide rests, oil separators for removing oil from chips, turnings and cuttings, and other tools and appliances. 6 by 9¼ in.; pp. 33. American Tool & Machine Co., Boston.

Nernst Lamps.

Booklet, entitled "The Value and Utility of the Nernst Lamp in the Central Station," showing the many advantages of this electric lamp for various kinds of lighting, particularly in the field between arc and incandescent lamps. 6 by 3½ in.; pp. 16. The Nernst Lamp Co., Pittsburg.

Pipe.

Folder, describing and illustrating Root spiral riveted pipe, and containing detachable index card and postal card. 7½ by 3½ in.; pp. 8. Also, folder devoted to Root spiral riveted bilge pumps and A. & R. exhaust heads. Abendroth & Root Mfg. Co., Newburgh, N. Y.

Pneulubric.

Folder, describing "Pneulubric," a lubricant for pneumatic tools, which is made in solid and liquid forms, the former being especially adapted to rotary drills, and the latter to hammers, riveters and air compressors. 5¾ by 3½ in.; pp. 6. Philadelphia Pneumatic Tool Co., 21st St. and Allegheny Ave., Philadelphia.

Pneumatic Hammers.

Pamphlet, illustrating and describing Haeseler "axial-valve" pneumatic hammers, for chipping, riveting, and other purposes. 3½ by 8¼ in.; pp. 10. The Ingersoll-Sergeant Drill Co., Pneumatic Tool Department, 26 Cortlandt St., New York.

Pneumatic Tubes.

Book, containing half-tone illustrations and descriptions of pneumatic-tube service as applied to the transportation of mail, messages, merchandise, cash, and other matter, and also of other carrying appliances for banks, factories, stores and libraries. 9¾ by 7 in.; pp. 48. American Pneumatic Service Co., Boston.

Presses.

Catalogue, containing illustrations and descriptions of a great variety of power presses, punches, shears, seamers, beading and flanging machines, plate-bending rolls, and other machines and appliances for sheet metal work. 8 by 5½ in.; pp. 176. Perkins Machine Company, Warren, Mass.

Screws.

Booklet, describing an electric welding method of making finished screws and bolts of iron, steel, brass, bronze, and other metals, and showing illustrations of screws. 6 by 3½ in.; pp. 12. Also folder devoted to finished steel machine bolts. The Cleveland Cap Screw Co., Cleveland, O.

Slotting Machines.

Catalogue No. 38, containing illustrations and descriptions of slotting machines of various kinds and sizes, including armor-plate, gear-cutting, railway-frog, traveling head, portable and other styles, both motor and belt driven, 9 by 6 in.; pp. 24. Newton Machine Tool Works, Inc., Philadelphia.

Steam Traps.

Booklet, entitled "A Short Talk to the Man Behind the Check Book," which describes in an entertaining way the advantages of the Bundy steam trap. 6 by 3½ in.; pp. 12. A. A Griffing Iron Company, Jersey City, N. J.

Thermit.

Folder, devoted to the aluminothermic process for welding of all kinds, repairing castings, reviving iron and steel in castings and ingots and preventing flaws and piping, producing rare metals free from carbon, and for other purposes, with illustrations of a rail-welding outfit and of a welded sternpost of an ocean steamer. 8½ by 3½ in.; pp. 6. Goldschmidt Thermit Co., 43 Exchange Place, New York.

Time Register.

Pamphlet, illustrating and describing the Dey time register, for recording the arrival and departure of employees, with facsimile of the records, list of users and testimonials. 9 by 5 in.; pp. 32. Also, card showing a record as made with a combination red and green ribbon, by which tardiness is detected at a glance. Dey Time Register Co., Syracuse, N. Y.

NEWS SUPPLEMENT

The Engineering Magazine—September, 1904

Coming Society Meetings.

American Boiler Manufacturers' Association. Sec.: J. D. Farasey, Cleveland. Next meeting, Oct. 4-6, at St. Louis.

American Gas Light Association. Sec.: A. E. Forstall, 58 William St., New York. Annual convention, Oct. 19-21, at Washington.

American Electrochemical Society. Sec.: S. S. Stadler, 39 S. 10th St., Philadelphia. Next meeting, Sept. 12-17, at St. Louis.

American Institute of Electrical Engineers. Sec.: Ralph W. Pope, 95 Liberty St., New York. Joint convention with Institution of Electrical Engineers, Sept. 14-17, St. Louis.

American Institute of Mining Engineers. Sec.: R. W. Raymond, 99 John St., New York. Annual convention, Sept. 14-21, at Duluth, Minn., and Houghton, Mich.

American Institute, Polytechnic Section. Sec.: George Whitefield, Jr., 19 W. 44th St., New York. Meetings on first and third Tuesdays of each month, from October to May, inclusive.

American Railway Association. Sec.: W. F. Allen, 24 Park Place, New York. Next meeting, Oct. 26, at Philadelphia.

American Railway Mechanical and Electrical Association. Sec.: Walter Mower, Detroit. Annual meeting, Oct. 10-15, at St. Louis.

American Society of Civil Engineers. Sec.: C. W. Hunt, 220 W. 57th St., New York. Regular meetings, first and third Wednesdays of each month, except July and August.

American Society of Municipal Improvements. Sec.: Geo. W. Tillson, Municipal Building, Brooklyn, N. Y. Annual meeting, Oct. 4-6, at St. Louis.

American Street Railway Association. Sec.: T. C. Penington, 2020 State St., Chicago. Annual meeting, Oct. 10-15, at St. Louis.

Association of Edison Illuminating Companies. Sec.: W. S. Barstow, New York and Portland, Ore. Next meeting Aug. 30-Sept. 1., New Castle, N. H.

Association of Railway Superintendents of Bridges and Buildings. Sec.: S. F. Patterson, Concord, N. H. Annual convention, Oct. 18-20, at Chicago.

Boston Society of Civil Engineers. Sec.: S. E. Tinkham, 715 Tremont Temple. Regular meetings on third Wednesday of each month, except July and August.

Brooklyn Engineers' Club. Sec.: J. Strachan, 191 Montague St. Regular meeting on second Thursday of each month.

Canadian Railway Club. Sec.: W. H. Rosevear, Jr., Montreal. Regular meetings on first Tuesday of each month, except June, July and August.

Canadian Society of Civil Engineers. Sec.: Prof. C. H. McLeod, 877 Dorchester St., Montreal. The General Section and the Electrical, Mechanical and Mining Sections meet on different Thursdays, from October to May.

Central Railway Club. Sec.: Harry D. Vought, 62 Liberty St., New York. Regular meetings on second Friday of January, March, May, September and November, Hotel Iroquois, Buffalo.

Chicago Electrical Association. Sec.: W. B. Hale, Monadnock Building. Regular meetings on first and third Fridays of each month, from October to May.

Civil Engineers' Club of Cleveland. Sec.: Joseph C. Beardsley, 689 The Arcade. Regular meetings on second and fourth Tuesdays of each month.

Civil Engineers Society of St. Paul. Sec.: G. S. Edmondstone. Regular meetings on second Monday of each month.

Connecticut State Street Railway Association. Sec.: E. W. Poole, Bridgeport. Annual meeting in November.

Engineering Association of the South. Sec.: Robt. L. Lund, 2102 Hayes St., Nashville, Tenn. Regular meetings on second Thursday of each month at the Berry Block. Convention at St. Louis.

Engineers' Club of Chicago. Sec.: B. W. Thurtell, 1223 New York Life Building. Regular meetings on first and third Tuesdays of each month.

Engineers' Club of Cincinnati. Sec.: J. F. Wilson, P. O. Box 333. Regular meeting on third Thursday of each month, except July and August.

Engineers' Club of Columbus (Ohio). Sec.: H. M. Gates, 5½ West Broad St. Regular meetings on third Saturday of April, May, June and September, and on first and third Saturdays from October to March, inclusive.

Engineers' Club of Minneapolis. Sec.: Jas. B. Gilman, American Bridge Co. Regular meetings on third Monday of each month, except July and August.

Engineers' Club of Philadelphia. Sec.: J. O. Clarke, 1122 Girard St. Regular meetings on first and third Saturdays of each month, except July and August.

ENGINEERS' CLUB OF ST. LOUIS. Sec.: H. J. Pfeifer, 920 Rialto Bldg. Regular meetings on first and third Wednesdays of each month.

ENGINEERS' SOCIETY OF WESTERN NEW YORK. Sec.: H. B. Alverson, 533 Ellicott Square, Buffalo. Regular meetings on first Tuesdays of each month, except July and August.

ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA. Sec.: Chas. W. Ridinger, 410 Penn Ave., Pittsburg. Regular meetings on third Tuesday of each month.

FRANKLIN INSTITUTE. Sec.: Dr. Wm. H. Wahl, 15 South 7th St., Philadelphia. General meetings on third Wednesday of each month, except July and August. General section meetings every Thursday.

HONOLULU ENGINEERING ASSOCIATION. Sec.: G. F. Bush, Honolulu, Hawaii.

INDEPENDENT TELEPHONE ASSOCIATION OF THE UNITED STATES OF AMERICA. Sec.: Frank G. Jones, 48 W. Jackson Boulevard, Chicago. Next meeting, Sept., at St. Louis.

INDIANA PUBLIC UTILITIES ASSOCIATION. Sec.: A. M. Barron, South Bend, Ind. Next meeting, Oct. 18, at Indianapolis.

INSTITUTION OF ELECTRICAL ENGINEERS. Sec.: G. C. Lloyd, 92 Victoria St., Westminster, London. Joint convention with Am. Inst. of Elect. Engrs., Sept. 14-17, at St. Louis.

INTERNATIONAL ASSOCIATION OF MUNICIPAL ELECTRICIANS. Sec.: Frank P. Foster, Corning, N. Y. Meeting, Sept. 13-14 at St. Louis.

INTERNATIONAL CONGRESS OF ARTS AND SCIENCE. Sec.: Howard J. Rogers, Universal Exposition, St. Louis. Meeting, Sept. 19-25, at St. Louis.

INTERNATIONAL ELECTRICAL CONGRESS. Sec.: Dr. A. E. Kennelly, Harvard University, Cambridge, Mass. Meeting, Sept. 12-17, at St. Louis.

INTERNATIONAL ENGINEERING CONGRESS. Sec.: Charles Warren Hunt, 220 W. 57th, St., New York. Meeting, Oct. 3-8, at St. Louis.

INTERNATIONAL RAILWAY CONGRESS. General Sec.: Louis Weissenbruch, Belgian State Railways, Brussels, Belgium. Sec. of American Section: W. F. Allen, 24 Park Place, New York. Seventh session, May 3-15, 1905, at Washington.

IOWA RAILWAY CLUB. Sec.: P. B. Vermillion, Des Moines, Iowa. Regular meetings on third Tuesday of each month.

IRON AND STEEL INSTITUTE. Sec.: B. H. Brough, 28 Victoria St., London, S. W. Annual meeting, Oct. 24-26, at New York.

LOUISIANA ENGINEERING SOCIETY. Sec.: G. W. Lawes, 806 Gravier St., New Orleans. Regular meetings on second Monday of each month.

MASSACHUSETTS STREET RAILWAY ASSOCIATION. Sec.: Charles S. Clark, 70 Kilby St., Boston. Meetings second Wednesday of each month, except July and August.

MONTANA SOCIETY OF ENGINEERS. Sec.: Clinton H. Moore, Butte, Mont. Regular meetings on second Saturday in each month.

NATIONAL ELECTRICAL CONTRACTORS' ASSOCIATION OF THE UNITED STATES. Sec.: W. H. Morton, Utica, N. Y. Annual convention, Sept. 14-16, at St. Louis.

NATIONAL ELECTRIC LIGHT ASSOCIATION. Sec.: Ernest H. Davis, 136 Liberty St., New York. Meeting, Sept., at St. Louis.

NEW ENGLAND RAILROAD CLUB. Sec.: Edw. L. Janes, Back Bay P. O., Boston. Regular meetings, second Tuesday in each month, except June, July, August and September, at Pierce Hall, Copley Square.

NEW ENGLAND STREET RAILWAY CLUB. Sec.: J. H. Neal, 101 Milk St., Boston. Meetings on last Thursday of each month.

NEW YORK ELECTRICAL SOCIETY. Sec.: Geo. H. Guy, 114 Liberty St., New York. Meetings monthly, on different Wednesdays, at the American Institute, 19 W. 44th St.

NEW YORK RAILROAD CLUB. Sec.: Harry D. Vought, 62 Liberty St., New York. Regular meetings on third Friday of each month, except June, July and August, at Carnegie Hall, 154 W. 57th St., New York.

NEW YORK STREET RAILWAY ASSOCIATION. Sec.: W. W. Cole, Elmira. Annual meeting, Oct. 11 and 12, at Utica.

NORTHWESTERN ELECTRICAL ASSOCIATION. Sec.: Thos. R. Mercein, Milwaukee. Annual convention, Sept., at St. Louis.

NORTH-WEST RAILWAY CLUB. Sec.: T. W. Flannagan, Minneapolis, Minn. Regular meetings on first Tuesday after second Monday of each month, except June, July and August, alternating between Minneapolis and St. Paul.

OHIO SOCIETY OF MECHANICAL, ELECTRICAL AND STEAM ENGINEERS. Sec.: Corwin J. Miller, Canton. Next meeting, Nov. 18, at Canton.

PACIFIC COAST ELECTRICAL TRANSMISSION ASSOCIATION. Sec.: Geo. P. Low, 237 Cherry St., San Francisco. Annual convention, third Tuesday in June. Intermediate meetings subject to call.

PACIFIC COAST RAILWAY CLUB. Sec.: C. C. Borton, West Oakland, Cal. Regular meetings on third Saturday of each month at San Francisco and other cities.

PACIFIC NORTHWEST SOCIETY OF ENGINEERS. Sec.: Prof. M. Roberts, Seattle, Wash. Meetings monthly in Chamber of Commerce rooms, Seattle.

RAILWAY CLUB OF PITTSBURG. Sec.: J. D. Conway, P. & L. E. R. R., Pittsburg, Pa. Regular meetings on fourth Friday of each month, except June, July and August, at Hotel Henry.

RAILWAY SIGNAL ASSOCIATION. Sec.: B. B. Adams, 83 Fulton St., New York. Next meeting, Sept. 13, at Chicago. Annual meeting, Oct. 11, at St. Louis.

RAILWAY WATER SUPPLY ASSOCIATION. Sec.: F. W. Hayden, Glencoe, Minn. Meetings on first Sunday of each quarter at Alexander Hall, South Minneapolis, Minn.

RICHMOND RAILWAY CLUB. Sec.: F. O. Robinson, 8th & Main Sts., Richmond, Va. Regular meetings on second Thursday of each month, except June, July and August.

ROADMASTERS' AND MAINTENANCE-OF-WAY ASSOCIATION. Sec.: C. E. Jones, Beardstown, Ill. Annual meeting, Sept. 13-15, at St. Louis.

ROCKY MOUNTAIN RAILWAY CLUB. Sec.: M. M. Currier, Colorado City. Regular meetings on second Tuesday of each month, except June, July and August, at Union Depot, Denver.

ST. LOUIS RAILWAY CLUB. Sec.: E. A. Chenery, Union Station, St. Louis. Regular meetings on second Friday of each month, except July and August.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION. Sec.: C. A. Waldo, Purdue University, Lafayette, Ind. Annual convention, Sept. 1-3, at St. Louis.

SOCIETY OF CHEMICAL INDUSTRY. Gen'l Sec.: C. G. Cresswell, 9 Bridge St., Westminster, London. Sec., New York Section, T. J. Parker, 25 Broad St., N. Y. Annual meeting, Sept. 7-12, at New York.

TECHNICAL SOCIETY OF THE PACIFIC COAST. Sec.: Otto von Geldern, 31 Post St., San Francisco. Regular meetings on first Friday of each month.

TEXAS RAILWAY CLUB. Sec.: T. H. Osborne, Pine Bluff, Ark. Regular meetings on third Monday of April and September.

TOLEDO SOCIETY OF ENGINEERS. Sec.: L. M. Gram, 519 Gardner Building, Toledo, O. Meetings on third Friday of each month in National Union Building.

TRAVELING ENGINEERS' ASSOCIATION. Sec.: W. O. Thompson, Oswego, N. Y. Next meeting, Sept. 13, at Chicago.

VERMONT ELECTRICAL ASSOCIATION. Sec.: C. C. Wells, Middlebury. Next meeting, Sept. 21 and 22, at Montpelier.

WESTERN RAILWAY CLUB. Sec.: J. W. Taylor, 667 Rookery, Chicago. Meetings on third Tuesday of each month, except June, July and August, Auditorium Hotel, Chicago.

WESTERN SOCIETY OF ENGINEERS. Sec.: J. H. Warder, Monadnock Block, Chicago. Regular meetings on first Wednesday and extra meetings on third Wednesday of each month, except July and August.

Personal.

—Mr. James W. Lyons announces his resignation as manager of the Power Department of the Allis-Chalmers Co. Mr. Lyons has taken this step in order to accept the appointment as consulting engineer to the Elgin Watch Company, of Elgin, Ill., who will erect new and extensive works under his supervision. Mr. Lyons will also engage in other consulting work, and his headquarters will be at Chicago.

—Mr. Wm. H. Armstrong, formerly manager of the New York business for the Chicago Pneumatic Tool Company, is now associated with the Ingersoll-Sergeant Drill Company, of 26 Cortlandt Street, New York, and will look after the interests of the Pneumatic Tool Department.

—Mr. Arthur Visick, formerly of the Napier Company, one of the most prominent manufacturers of motor cars in England, has been appointed representative for the Packard Motor Car Company, of Detroit, at St. Louis. Mr. Visick has had a wide experience abroad in connection with the Woolsey and Napier factories and is thoroughly posted on all the leading European cars; this experience will be of particular value to him in his present position in charge of the Packard exhibit in the Transportation Building at the St. Louis Fair.

—Mr. Roscoe Cornell has been appointed manager of the branch office which the Allis-Chalmers Co. has just opened in El Paso, Texas. Mr. Cornell goes to the Allis-Chalmers Co. from the Mine & Smelter Supply Co. of Denver. He is a graduate of the Michigan College of Mines, and is well known as a mining and mechanical engineer. He has held a number of prominent positions as a mining engineer, and as a smelter and mine superintendent. His acquaintance is extensive, and he is thoroughly qualified to fill the important position to which he has just been appointed.

Industrial Notes.

—Messrs. Gunn, Richards & Co., the well known production engineers, who have organized and installed cost-keeping systems in some of the largest engineering plants and manufacturing establishments in the country, have moved their offices to a suite of rooms in the Wall Street Exchange Building, 41 Wall St. and 49 Exchange Place, New York.

—The Brown Corliss Engine Co. have just opened a department for building high-speed engines and are now working on two units of 150 horse power each, three of 250 horse power, two of 50 horse power and one of 75 horse power, all to be direct connected. They have also recently shipped a 3,000-horse-power rolling-mill engine to the Lorain Steel Co., of Lorain, O.

—The Reeves Engine Company have opened a branch office at 2220 Land Title Building, Philadelphia, which will be under the direction of W. E. S. Dyer. Among the recent sales of this company are an engine to the Diamond Rubber Company, of Akron, O., for connection to a 150-kilowatt generator, and a vertical cross-compound engine to the Brier Hill Iron & Coal Company, for direct connection to a 250-kilowatt generator.

—The Grand Trunk Railway has compiled a little book telling about Canadian fishing resorts, how to get to them, rates, hotel accommodations, etc. This book may be obtained on application to G. T. Bell, General Passenger and Ticket Agent, Grand Trunk Railway System, Montreal, Quebec.

—The Chicago Bridge & Iron Works, of Chicago, are the builders of the turntable which forms part of the Big Four Route's striking exhibit at the St. Louis Exposition, where a locomotive and tender, built by the American Locomotive Co., with a total weight of 324,000 pounds, are shown in motion on the turntable, the latter moving also.

—The Westinghouse Companies' Publishing Department has issued a tasteful pamphlet on the "Westinghouse Industries, as Exemplified at the Louisiana Purchase Exposition," which contains accounts of the various Westinghouse companies, and descriptions and handsome illustrations of the principal works and of some of the important apparatus manufactured.

—The firm of Henry R. Worthington has published a small map showing the location of its old works in South Brooklyn, the offices in Manhattan and the new works at Harrison, N. J., with the intercommunicating lines of transportation. The old works were founded in 1840 and now cover about 4½ acres and employ 2,000 men. The new plant occupies a 34-acre tract, has 18 acres of floor space and will accommodate 6,000 workmen. It is said to be the largest industrial plant near New York, and embraces the latest improvements in production engineering.

—The O'Rourke Engineering & Construction Co., which firm has the contract for building the Pennsylvania Railroad Tunnel under the Hudson River, has placed an order with the Ingersoll-Sergeant Drill Co. for two central compressed-air power plants to be located at New York City and Weehawken, N. J. This order includes eight 36-inch stroke Corliss air compressors, each of 3,890 cubic feet capacity. With the O'Rourke plant installed, the total number of Ingersoll-Sergeant compressors supplying air for subaqueous tunnels in New York will be as follows: 6 Class "A" straight line compressors; 10 Corliss duplex compressors; 3 Class "H" duplex compressors; 2 Class "G" duplex compressors.

—Manning, Maxwell & Moore have secured a large order from the Illinois Central R. R., amounting to between $150,000 and $160,000 worth of tools, to be shipped to the various shops along their lines. This is one of the best orders for machine tools that has been placed in a long time. The order consists of a full line of railroad tools, such as driving-wheel lathes, axle lathes, car-wheel borers, steam hammers, large and small engine lathes, a very large quantity of punching and shearing machinery, woodworking tools, radial drills, shapers, bolt cutters, brass lathes, grinding machinery, planers, steel-tired-wheel lathes, slotting machines, vertical and horizontal boring machines, centering machines, a full line of tool room tools and milling machines. Manning, Maxwell & Moore have also secured the order for all the electric traveling cranes required to go with these tools.

—The Weston Electrical Instrument Company, of Newark, N. J., at the request of the Bureau of Statistics of Labor and Industries of the State of New Jersey, have prepared for the Louisiana Purchase Exposition a very tasteful and interesting pamphlet giving an account of their social features and, especially, of their Employees' Club. When the new Weston plant was built in the Waverly district of Newark, the Company reserved the most desirable portions of the premises, including several commodious halls, and furnished them as recreation room, library, kitchen, dining room, gymnasium, natatorium, bicycle depot, hospital, and so on. This entire outfit, with a working capital of $1,000 contributed by a director, was formally transferred to the employees, who completed the formation and incorporation of the "Weston Employees' Club of Newark, New Jersey." This club is run entirely by the employees, acting through a board of governors and several standing committees, and is active in a number of ways. In the large dining room a bountiful and attractive lunch is served every day at an extremely reasonable price, either table d'hôte or à la carte. In the large recreation hall are pool and billiard tables, a baby-grand piano and pianola, chess, checkers, cribbage, dominoes and other games, and the commencement of a gymnasium, and here entertainments are held fortnightly, the performers being exclusively the employees themselves. Outside of the club, the greatest attention is paid to the health and well-being of the employees, and the lighting, heating, ventilating and sanitary arrangements of the factory are of the best and most modern kind. The pamphlet that has been referred to gives also some description of the works and buildings, is well illustrated, and presents a very attractive picture of harmonious and mutually beneficial relations between employers and employees at a highly successful establishment.

—Dodge & Day, Modernizing Engineers, Philadelphia, have lately completed the installation of the 340-horse-power Buckeye vertical, cross-compound engine, direct connected to two General Electric 100-kilowatt, continuous-current, compound-wound generators for the Link-Belt Engineering Company. The same concern are at work on a three-motor, electrically-operated locomotive crane for this company, to handle beams, angle irons and other heavy structural material for use in their new storage yard.

—The General Electric Company have selected Cochrane feed-water heaters for their plants at West Lynn, Mass., and Harrison, N. J., where Curtis steam turbines are to be installed. These heaters are rated at 3,000 and 1,000 horse power, respectively, and will take the exhaust steam from the auxiliaries. Three 5,000-horse-power Cochrane heaters have also been installed in connection with steam turbines at the Delway (Mich.) station of the Detroit Edison Co., and a 600-horse-power feed-water heater will be used in the new turbine station of the Iowa and Illinois Interurban Railway Co., Clinton, Ia. A 2,000-horse-power Cochrane heater which has been ordered by the Electric Co. of America will be installed with steam turbines in their new plant at Marion, Ind. All these Cochrane heaters are supplied by the Harrison Safety Boiler Works, of Philadelphia.

—The Eureka Fire Hose Co., of 13 Barclay St., New York, has a striking exhibit in Chief Hale's Fire Fighting Exposition at the St. Louis World's Fair, in the shape of a pagoda standing more than twenty feet high. The roof is constructed of play pipes, the side arches formed of Eureka hose, and the rest of the pavilion built of pipe couplings and other fire department material. The Eureka Company also has a fine exhibit in Machinery Hall, showing all its various products to advantage.

—The B. F. Sturtevant Co. is fitting up quarters in its big plant to be used for an emergency hospital, in case of accident to employees. It is to be equipped with all the appliances known to medical and surgical science for the proper care of the men who may get injured in the discharge of their duties until they can be removed to their homes. A graduate nurse and medical student will be in charge and a local doctor will attend to all surgical cases.

—The Frick Company, of Waynesboro, Pa., builders of the Eclipse ice making and refrigerating machinery, Corliss engines and steam boilers, have an elaborate display of their machinery at the St. Louis World's Fair, in the Agricultural Palace, Section 11. They have a small refrigerating plant in operation on the grounds and quite a number of various sized plants operating in the City of St. Louis or its immediate vicinity, to any of which their representative in charge, Mr. Jno. C. Emmert, will be pleased to personally direct.

—The International Congress of Arts and Science will be held at the St. Louis Exposition, September 19 to 25. The idea of the Congress grows out of the thought that the subdivision and multiplication of specialties in science has reached a stage at which investigators and scholars may derive both inspiration and profit from a general survey of the various fields of learning, planned with a view of bringing the scattered sciences into closer mutual relations. The central purpose is the unification of knowledge, an effort toward which seems appropriate on an occasion when the nations bring together an exhibit of their arts and industries. An assemblage is therefore to be convened at which leading representatives of theoretical and applied sciences shall set forth those general principles and fundamental conceptions which connect groups of sciences, review the historical development of special sciences, show their mutual relations and discuss their present problems. The speakers to treat the various themes are selected in advance from Europe and America. The discussions will be arranged on the following general plan: After the opening of the Congress on Monday afternoon, September 19, will follow, on Tuesday forenoon, addresses on main divisions of science and its applications, the general theme being the unification of each of the fields treated. These will be followed by two addresses on each of the twenty-four great departments of knowledge. The theme of one address in each case will be the fundamental conceptions and methods, while the other will set forth the progress during the last century. The preceding addresses will be delivered by Americans, making the work of the first two days the contribution of American scholars. On the third day, with the opening of the sections, the international work will begin. About 128 sectional meetings will be held on the four remaining days of the Congress, at each of which two papers will be read, the theme of one being suggested by the relations of the special branch treated to other branches; the other by its present problems. Three hours will be devoted to each sectional meeting, thus enabling each hearer to attend eight such meetings, if he so desires. The programme is so arranged that related subjects will be treated, so far as possible, at different times. The length of the principal addresses being limited to forty-five minutes each, there will remain at least one hour for five or six brief communications in each section. The addresses in each department will be collected and published in a special volume. It is hoped that the living influence of this meeting will be yet more important than the formal addresses, and that the scholars whose names are announced in the programme of speakers and chairmen will form only a nucleus for the gathering of thousands who feel in sympathy with the efforts to bring unity into the world of knowledge.

—The International Railway Congress will hold its seventh session at Washington, from the 3rd to the 15th of May, 1905. This association includes many of the leading railroad men of the world, and the principal governments are formally represented at its sessions, which have been held at intervals since 1885, in some of the chief cities of Europe.

—The Power and Mining Machinery Company started business a little over a year ago, having secured the works of the Holthoff Mining Machinery Company at Milwaukee, where it immediately commenced extensive improvements for the manufacturing of its gas machinery. The extension of these works was begun in August, 1903, less than one year ago, and they are hardly completed, but will be ready within sixty days for extensive operations. In the meanwhile, the Company has taken upwards of a million dollars' worth of orders for Loomis-Pettibone gas apparatus and Crossley gas engines, which are being constructed in their shops at the present time. These orders have been placed with the most representative and conservative companies, among which are the following: —Velardena Mining & Smelting Company, Velardena, Durango, Mexico; F. W. Snow, Hillburn, N. Y.; Gould Coupler Company, Depew, N. Y.; D. Lovejoy & Son, Lowell, Mass.; Ramapo Iron Works, Hillburn, N. Y.; Pennsylvania Steel Company, Steelton, Pa.; Dufresne & Locke, Montreal, P. Q., Canada; Milford Electric Light Company, Milford, N. H.; Motor Engine Company, 15 William Street, New York City; Potosins Electric Company, San Luis Potosi, S. L. P., Mexico; Amparo Mining Company, Drexel Building, Philadelphia, Pa.; International Steam Pump Company, 114 Liberty Street, New York City; Atha Tool Company, Newark, N. J.; Elmira Water, Light & Railroad Company, Elmira, N. Y.; Sayles' Bleacheries, Saylesville, R. I.; W. H. Cone, Berlin, Ont., Canada; Bay State Forge, Cambridge, Mass.: Taylor Manufacturing Co., Columbia, S. C.; and others.

NEW CATALOGUES AND TRADE PUBLICATIONS

These catalogues may be had free of charge on application to the firms issuing them. Please mention The Engineering Magazine when you write.

Belt Lacing Machine.

Booklet, with illustrations and descriptions of the Jackson belt lacing machine, both hand and power driven, and of wire coil clasp lacing, which makes a strong and flexible joint. 6 by 3½ in.; pp. 16. Diamond Drill & Machine Co., Birdsboro, Pa.

Boiler.

Catalogue, containing half-tone illustrations of the Rust water-tube boilers, in which the tubes are straight and vertical and the drums are fitted with the Rust patent pressed tube sheet, the advantages of which are clearly brought out. 9 by 6 in.; pp. 38. The Rust Boiler Company, Pittsburg.

Bolt and Nut Machinery.

Large catalogue, containing descriptions and illustrations of a great variety of bolt and nut machinery, forging and bending machines, wire nail, spike and special machinery, with tables of screw threads, nuts, bolts, rivets and other useful data, and an index. 8 by 10 in.; pp. 169. The National Machinery Co., Tiffin, O.

Cement.

Pamphlet, entitled "The Test of Time," devoted to "Giant" Portland cement, and giving illustrations of some of the great engineering works where this cement has been used, including the New York Rapid Transit Subway, the Williamsburg Bridge, the Rockville Bridge of the Pennsylvania Railroad, the New Croton Dam, the Wachusett Dam, the tunnel of the Niagara Falls Power Company, and many others. 6 by 9 in.; pp. 32. American Cement Co., 22 South 15th St., Philadelphia.

Centrifugal Pumps.

Catalogue No. 11, Revised, containing illustrations, descriptions and prices of many styles of centrifugal and suction pumps and pumping engines, turbine pumps, vertical steam engines, valves, connections and other fittings, and information about centrifugal pumping machinery. 6 by 9 in.; pp. 55. The Lawrence Machine Co., Lawrence, Mass.

Concrete Construction.

Pamphlet containing an interesting little treatise on concrete, its properties, and its applications, both alone and when reinforced by steel, with illustrations of various concrete structures. 9 by 6 in.; pp. 20. Engineering Company of America, 74 Broadway, New York.

Condensing Apparatus.

Booklet with illustrations of barometric and surface condensers, cooling towers and other types of condensing apparatus and vacuum and circulating pumps which have been manufactured and installed in connection with steam turbines and reciprocating engines where high vacuum is a necessity. 6 by 3½ in.; pp. 20. Alberger Condenser Company, 95 Liberty St., New York.

Conveyors.

Catalogue No. 67 A, containing descriptions and illustrations of Jeffrey "Century" rubber-belt conveyors, built in sections, with adjustable side guides and in other styles, with adjustable troughing and other kinds of carriers, for handling barrels, bags, packages, coal, ore and other materials, and also of other kinds of conveying and handling machinery. 9 by 6 in.; pp. 48. The Jeffrey Manufacturing Co., Columbus, O.

Core Boxes.

Circular, containing illustrations and price list of "Perfection" core boxes for accurate straight round cores from ½ inch to 6½ inches in diameter; with mention of other foundry supplies. 9½ by 6 in.; pp. 4. The J. D. Smith Foundry Supply Co., Cleveland O.

Crushers.

Booklet, describing and illustrating the Kimplen rock and ore crushers, with independent sets of jaws, of great capacity and very economical of power. 3½ by 6 in.; pp. 12. Also, booklet devoted to the K. mill, for pulverizing ores and other substances. 3½ by 6 in.; pp. 12. Kimplen Crusher and Pulverizer Co., 100 Washington St., Chicago.

Electric Driving.

"Industrial series" publication No. 13001, entitled "Machine Tool Drive," containing an instructive explanation and description of the advantages of electric driving for machine tools, illustrated with many views of all kinds of tools operated by electric motors. 9 by 6 in.; pp. 42. Westinghouse Electric & Manufacturing Co., Pittsburg.

Bulletin No. 1028, containing a well illustrated description of the Bullock multiple-voltage system of control for variable-speed electric motors adapted to the driving of machine tools. 9 by 6 in.; pp. 24. Also, pamphlet with illustrations and descriptions of representative types of Bullock electric apparatus, including some which is exhibited at the St. Louis Fair, and views of the Bullock works. 6¾ by 5½ in.; pp. 32. The Bullock Electric Mfg. Co., Cincinnati.

Electric Fans.

Leaflet No. 131, with illustrations of different styles of Northern electric motors driving, respectively, a Connersville cupola blower, a Bayley fan, an American Blower Co.'s fan, a Blackman fan, and a Buffalo forge blower. 6 by 3½ in.; pp. 4. Northern Electrical Mfg. Co., Madison, Wis.

Engine Works.

Pamphlet, with description, half-tone illustrations and plan of the works of The William Tod Co., showing their excellent facilities for building steam engines and manufacturing heavy machinery. 10 by 8 in.; pp. 18. The William Tod Co., Youngstown, Ohio.

Gas Engines.

Large pamphlet, containing illustrations and descriptions of Cockerill blast-furnace-gas blowing engines and their valve gear, and also list of 121 Cockerill gas engines in use, in units of from 100 to 3,000 horse power, with a total of 80,000 horse power. 12 by 9 in.; pp. 11. The Wellman-Seaver-Morgan Co., Cleveland, O.

Gold Dredges.

Catalogue No. 2, with illustrations and descriptions of Bewsher sand pumps and gold-dredging machinery, including the combination suction-bucket dredge and monitor, in which are incorporated the suction dredge, the endless-chain bucket dredge, and the monitor or hydraulic giant for sluicing. 8 by 11 in.; pp. 15. General Construction Co., Seattle, Wash.

Locomotives.

Pamphlet containing illustrations and descriptions of twelve representative passenger and freight locomotives, exhibited at the St. Louis Fair, including a four-cylinder compound balanced locomotive for high-speed passenger service and a four-cylinder articulated locomotive for the heaviest freight service, the latter said to be the heaviest and most powerful locomotive ever built. 6 by 9 in.; pp. 44. American Locomotive Company, New York.

"Record of Recent Construction," No. 47, containing illustrations and descriptions of locomotives exhibited at the St. Louis Fair, including compound passenger and freight locomotives, electric locomotives, and various other types, and electric motor trucks; and also a historical review of the locomotives built at the Baldwin Works, with illustrations of every thousandth locomotive from the first, in 1832, to the twenty-four thousandth, in 1904, inclusive. 6 by 9 in.; pp. 77. Baldwin Locomotive Works, Philadelphia.

Machine Tools.

Booklet, with illustrations of gear-feed new model plain milling machines, plain horizontal milling machines, vertical milling machines, gear-feed new model universal milling machine, automatic gear cutting machine, cutter and reamer grinders, motor-driven planer-type milling machine, and other Becker-Brainard machine tools exhibited at the St. Louis World's Fair. 6 by 3½ in.; pp. 16. Becker-Brainard Milling Machine Co., Hyde Park, Mass.

Booklet, with half-tone illustrations of big-bore turret lathe, horizontal boring mill, vertical boring and turning mill, universal tool grinder and other machine tools. 6¾ by 5 in.; pp. 16. Also, bulletin leaves, devoted to new machinery and new methods of finishing various parts of machines. Gisholt Machine Co., Madison, Wis.

Pneumatic Machinery.

Pamphlet illustrating and describing the McGrath pneumatic railroad locomotive turntable motor and attachments; this motor may be operated by air from the shop plant or from the Westinghouse plant on the locomotive. 6 by 9 in.; pp. 8. Also, pamphlet devoted to McGrath pneumatic flue welders, flue welder and swedger and flue welder and scarfer. 9 by 6 in.; pp. 4. The Draper Manufacturing Co., Port Huron, Mich.

Pulverizers.

Catalogue, containing illustrations and descriptions of Straker's "Cyclone" disintegrators and pulverizers, for all kinds of materials, with either air or screen separation, the "Wilson" canvas-tube dust collector, the "Blake" rock and ore crusher, screens, bucket elevators, spiral conveyors, and other apparatus for pulverizing and disintegrating plants. 9¾ by 7 in.; pp. 64. E. H. Stroud & Co., 30-36 La Salle St., Chicago.

Catalogue, containing illustrations and descriptions of a complete line of pebble mills, in various styles, consisting of revolving cylinders containing flint pebbles or porcelain balls, for pulverizing all kinds of substances, "Max" vertical mills, cage disintegrators, rotary cutters, crushers, and other machinery. 9 by 6 in.; pp. 77. Abbé Engineering Company, 220 Broadway, New York.

Pumps.

Bulletin K 73, with illustration and description of the Knowles "Express" pump, and diagram giving result of test which showed an efficiency of 93 per cent. This pump is of the reciprocating type, directly connected to an electric motor without gears or belts, and runs at a speed of 300 revolutions per minute. 9 by 6 in.; pp. 4. Knowles Steam Pump Works, 114 Liberty St., New York.

Catalogue, containing illustrations and descriptions of the Emerson double-cylinder steam pump, particularly adapted for mines, quarries, irrigation, cofferdams, sinking, prospecting and similar work, and of the Emerson quick-cleaning strainer and foot valve, with useful data and tables. 9 by 6 in.; pp. 24. The Emerson Steam Pump Co., Washington, D. C.

Saw-Mill Machinery.

Catalogue, with descriptions and illustrations of high-speed saw-mill engine, band mills, band saws, resaws, timber yard saw mills, carriages, edgers, trimmers, log chains and sprockets, assorting lumber system, and other kinds of saw-mill and lumber machinery. 9 by 6 in.; pp. 107. McDonough Manufacturing Co., Eau Claire, Wis.

Vises.

Booklet, with illustration, description and price of the Humphrey heavy-duty vise, which weighs 175 pounds, has jaws 6½ inches wide and very deep in proportion to their length, and is very strong and well made in every way. 6 by 3½ in.; pp. 4. Humphrey & Sons, Joliet, Ill.

Wheel Press.

Circular No. 4, with illustration, description and price of the "Zelnicker" hydraulic wheel press, for forcing car wheels on to or off of axles, a very simple and substantial apparatus weighing only 1,250 pounds. 8½ by 3¾ in.; pp. 2. Walter A. Zelnicker Supply Co., St. Louis.

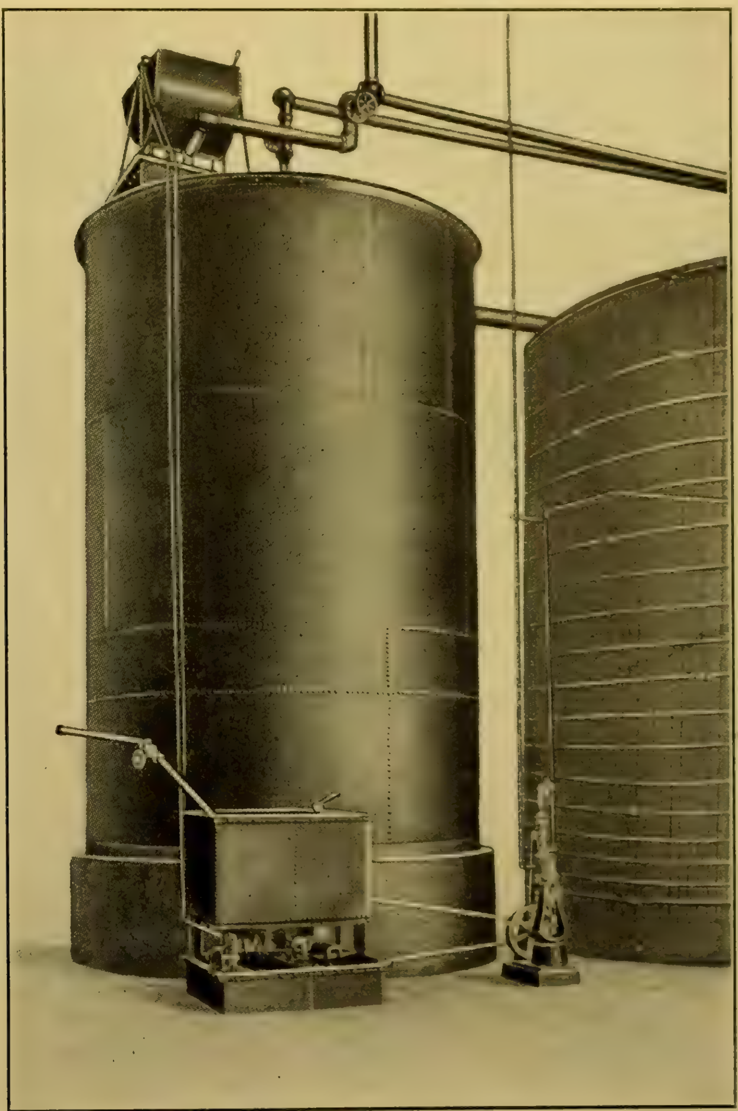
IMPROVED MACHINERY

New Processes and Appliances

The matter here published is not paid for, nor can it be classed as advertising. But as the information is necessarily obtained from those who offer the appliances for sale, it is proper to say that the manufacturers, rather than ourselves, are responsible for the statements made.

The Brunn-Loewener System for Softening Water.

IT is hardly necessary to emphasize the importance of having pure water for use in boilers where safe and efficient steam generation is desired, and when the natural supply of water is hard or impure, it becomes of the utmost interest to secure an effective and reliable system of water purification.



AMERICAN WATER SOFTENER AT PIEL BROTHERS STARCH WORKS, INDIANAPOLIS.

All water-softening systems involve the use of chemicals to precipitate scale-forming substances before the water enters the boiler; but methods differ, and it is by the excellence of its methods that the Brunn-Löwener system obtains remarkable results.

This system, which was invented by a Dane, and is controlled in the United States by the American Water Softener Company, involves apparatus of the simplest construction; there is practically nothing to get out of adjustment, and an ordinary fireman can give it all the attention it ever needs.

Lime and soda-ash, the cheapest reagents known, and purchasable in the open market, are used, and the apparatus mixes chemicals on the ground floor, which means a considerable saving in labor over other methods that make the elevation of chemicals necessary; while flowing water furnishes all the necessary motive power.

The lime *milk* used in this apparatus has a strength of 10 per cent., which being far greater than that of the lime-water used in some other systems, makes it possible to reduce in the same proportion the size of the tanks containing the lime. This effects a considerable saving of valuable space and renders practical the use of the Brunn-Löwener apparatus in plants that are cramped for room. The use of lime milk has this further advantage, that a fixed amount of freshly burned lime is mixed with a certain quantity of water, a solution being obtained the strength of which is always known.

The action is automatic; it starts and stops just as the water flows and stops flowing. No re-pumping into the storage tanks is needed, the water flowing into them from the top of the machine. Little attention is necessary, and it is very easy to mix a daily charge of chemicals, since the man in charge can do it without going to the top of the machine.

Of exceeding importance to the proper service of a water softener is the accurate mixing of chemicals and water, for it is only by such accuracy that the certain purification of water can be obtained. The tipping device in the Brunn-Löwener water softener absolutely assures this accuracy. The chemicals, which have been mixed on the ground floor to a certain strength, flow in definite amounts through the chemical valve above the tipper, at each oscillation of the tipper. A certain amount of water is needed to make this tipper oscillate, so that each tipperful of water is always treated with the correct amount of chemicals, whether the machine is running at full capacity or slowly.

Where the quality of water is changeable, it is only necessary to open and close the valve through which the chemicals flow, so that the correct amount of chemicals to be used, as shown by the very simple test of the water after treatment, can always be introduced.

Cases have been known where this apparatus was not looked after for months except for the addition of chemicals, and yet on testing the water it was found to be softened to the required degree, notwithstanding this long period of inattention.

Besides softening water for use in boilers, the Brunn-Löwener system may be used to great advantage for many other purposes. In laundries hard water plays havoc with soap. The lime salts in a thousand gallons of water will destroy 1.4 pounds of the best hard soap for each grain of carbonate of lime or its equivalent in the water, and this is all clear waste. Moreover the lime and magnesia in hard water combine with the fatty portion of the soap and form a greasy, insoluble and useless curd. This greasy curd gets into the fabric and resists rinsing; it spots and streaks the finished work. To soften the water means to save largely of soap, to make linen whiter, to prevent streaking and to give to laundering an appearance impossible to obtain with hard water.

In textile factories soft water shortens the time necessary for washing the cloth, makes it soft and smooth to the touch, and enables it to take the dye well and evenly. On the other hand, cloth treated with hard water is harsher, and the grease remaining in it from the soap prevents the dye from being properly absorbed, and has frequently the effect of dulling the colors.

In paper mills pulp absorbs impurities which can be precipitated and removed before the water is used.

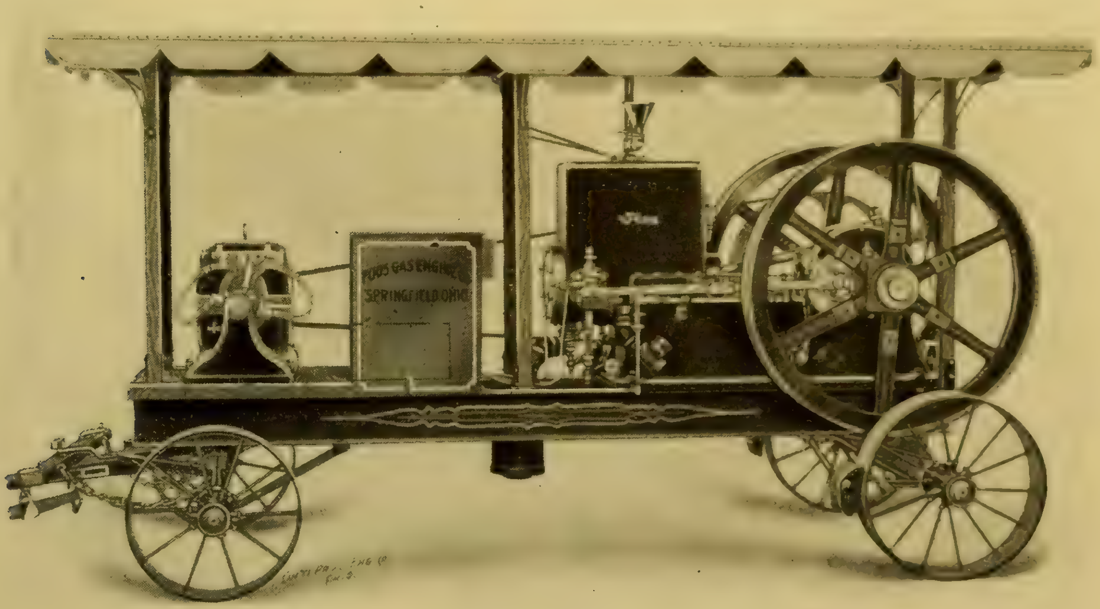
The Brunn-Löwener system has solved all manner of industrial problems involving the softening of water. By reason of its simple construction its first cost is low, and its operating expenses are also small.

Two general types of this apparatus are made: The rectangular, for the smaller industrial plants, and the upright for railroads and larger industrial plants, but the system is easily adjusted to changing conditions and requirements, and further information concerning it will be gladly furnished by the American Water Softener Co., Harrison Building, Philadelphia.

Portable Electric Power Plant.

WITH the perfection of the gasoline engine, it has become possible to design and construct a convenient and efficient portable electric power plant such as is shown in the accompanying illustration.

This outfit consists of a 22-horse-power Foos gasoline engine belted to a dynamo of corresponding capacity, and it is entirely self-contained, there being no accessory tanks, batteries or other details. It is mounted on a steel truck, and can be furnished with or without top and curtains. Such a portable plant may be employed to great advantage in operating electric tools, for temporary electric lighting, for thawing frozen water pipes, for running coal loaders, electric hoists and other contractors' apparatus and for many other purposes.



FOOS PORTABLE ELECTRIC POWER PLANT.

The gasoline engine is of the Foos portable type, and has the gasoline tank secured by brackets above the engine bed. The cylinder and water jacket are of a special design, and carry a sufficient supply of water to properly cool the cylinder. The water has a free passage to the air and maintains a uniform temperature, requiring no attention except that a bucket of water must be added occasionally to make up the loss due to evaporation. The cylinder is equipped with a complete water glass by which the height of water may be gauged. This method of cooling the cylinder does away with the cumbersome water tank and the circulating pump or fans often employed, and the advantages gained by freedom from water pipes and connections which may freeze or be broken by the vibration of operating and by hauling over rough roads, cannot be too strongly emphasized.

The Foos gas and gasoline engines are designed on the well-known four-cycle principle, giving an impulse at alternate revolutions of the flywheels. Nearly all the principal working parts being assembled on one side, the operator is enabled to install the engine to the best advantage, and to have free access to the devices for starting and for regulating speed, fuel and air supply, and time of ignition.

The system of ignition, on which depends in such a large measure the steady running and effective operation of an internal-combustion motor, has been very ingeniously worked out in these engines. The Foos igniter consists of two independent electrodes, the stationary and the revolving, each carrying a steel contact piece. The revolving blade coming in contact with the stationary spring at each revolution emits a large electric spark, while at the same time the wiping action of the two parts removes any deposit of burnt carbon or scale and prevents the incrustation of the contact edges, which is often the cause of so much trouble. This rubbing action of the Foos igniter keeps the points of contact brightly polished under all conditions of operation and thus insures continuous and even ignition. The blade and spring are in frictional contact for their full width of about half an inch, and this large contact surface, together with the hardness of the special steel used, makes them very durable. Adjustment for wear is made by simply loosening a locknut and moving the stationary electrode screw one-half turn or more toward the revolving electrode, and, when necessary, the blades can be renewed quickly and at trifling cost.

The Foos governor is very simple and compact, and so placed as to be accessible but still well protected. It is of the centrifugal type and regulates the supply of fuel by cutting out the charges beyond those required to maintain the proper speed. Plain poppet valves, having vertical motion transmitted positively to both valves, are used.

Another distinctive feature of the Foos engine is the system of counterbalancing, in which discs are bolted to the arms of the crank, thus leaving the flywheels in balance, the latter having no weights cast in their rims, and bringing the counterbalancing weights in direct line with the piston, connecting rod, crank and other parts to be balanced.

The material is carefully selected, phosphor bronze being used in all main bearings, and steel forgings for connecting rod, crank and such parts.

The design of the Foos engine is such as to make all parts unusually accessible, it being possible to remove either valve, either portion of the igniter, the cylinder head and so on, without disturbing any other part of the engine, or any pipe, fitting or other connection. The workmanship is of a very high grade, and the facilities of the large Foos factory, which is fully equipped with up-to-date and special tools, are most excellent.

Further information regarding these gas and gasoline engines and portable electric plants will be gladly furnished by the Foos Gas Engine Co., of Springfield, Ohio.

The Atlantic Steam Shovel.

THE great expansion that has taken place in power and capacity of locomotives and rolling stock of railways now finds its counterpart in the necessity for corresponding increase in power and capacity of the steam shovel. Ten years ago the standard railway shovel weighed 25 tons and carried a dipper of 1½ cubic yards capacity. The shovel of to-day weighs 60 to 70 tons and has a dipper of 2½ to 3½ cubic yards. Shovels are in use which weigh 90 tons and carry a dipper of 5 cubic yards capacity. Mere weight and size, however, do not give efficiency in service. Great weight, which is necessary in a locomotive, is a disadvantage in a steam shovel, because it not only makes it cumbersome and difficult to hold on temporary rails and soft ground, but makes it slow of movement.

The steam shovel, of which the 2½-yard dipper size is herewith illustrated, is a new machine which is being introduced by the Atlantic Equipment Company. It is built by the American Locomotive Company from the designs of Mr. A. W. Robinson, M. Am. Soc. C. E. This machine is the result of many years' experience in the design and operation of steam shovels and dredging machines and it includes all the desirable features of the best modern practice in shovel building. The steam shovel has become an indispensable machine to railroad companies and contractors engaged in construction work and the present machine has been brought out to meet the demand for a high-class shovel of greater speed, power and capacity. This shovel is built on locomotive lines and the quality of the design and workmanship throughout is fully up to the best class of locomotive construction.

The shovel illustrated is one in use by the New York Central & Hudson River Railroad, and another shovel of this size is at work on the new Pennsylvania Railroad Terminal excavation, New York City. It is a Class 38-16-2½ machine. This means a shovel having a pull upon the dipper of 38,000 pounds, a clear height of lift of 16 feet and a capacity of 2½ cubic yards. This system of numbering expresses at once any combination of these three elements in a shovel and is more systematic than the use of arbitrary numbers or letters of the alphabet commonly employed, which do not mean anything.

The distinguishing feature of this shovel is the direct wire-rope hoist. The friction loss in the chain hoist, to say nothing of the loss due to inertia, amounts to at least 40 per cent., whereas the loss in the case of direct wire rope hoist does not exceed 5 to 10 per cent. In the Atlantic shovel there is but a single sheave used for hoisting and this of very large size. This single sheave besides reducing friction has the very important advantage of increasing the angle of lead to the bucket. This is a most important feature, as it determines the digging efficiency of the machine. It is of but little use to exert a heavy pull upon the dipper by means of the hoisting chains if the angle formed by those chains on the dipper handle is so acute as to produce but little effect. In this shovel this angle is increased to such an extent that the digging effect is practically doubled. In other words, the same work can be done at higher speed and greater power and with a smaller expenditure of steam and less strain upon the machine.

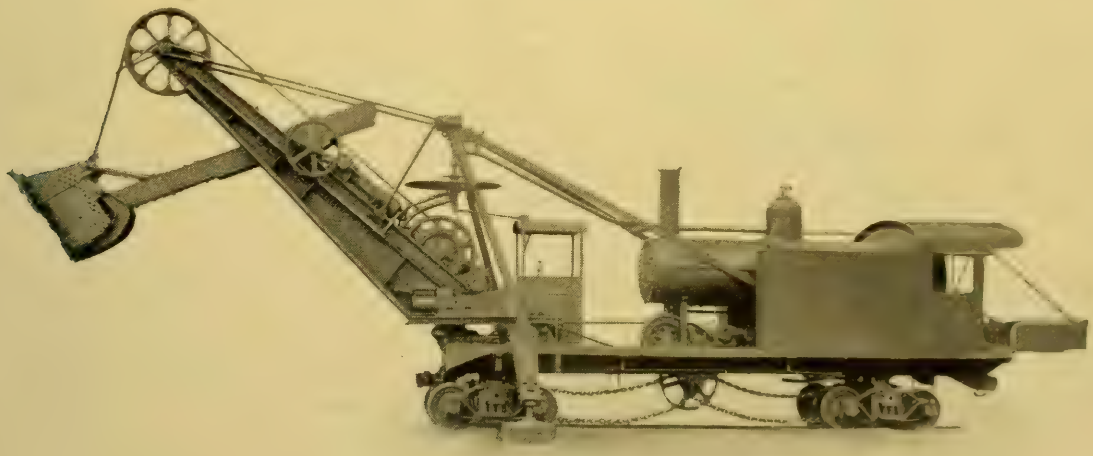
The hoisting engines are incorporated in the base of the boom, so that the whole hoisting machinery revolves together. The A frame is formed of solid steel bars having solid forged pin connections at feet and a cast-steel head. The A-frame head is of new design and so arranged that the three strains intersect in a point, so obviating all lateral bending strains which frequently lead to breakage. In the boom there is a departure from the usual practice by making it with straight taper deepest at the inner end.

The entire frame of the engines is of cast steel in one piece and forms the foot of the boom and center of the turntable as well. While the weight of the engines and gearing is not great, it is located on the axis of rotation of the boom and therefore does not appreciably increase the power required for swinging nor interfere with the speed.

In this shovel everything is covered that needs to be covered and the rest is left off and no woodwork whatever is employed. The boiler is covered with magnesia blocks and heavy sheet steel, painted. The working parts of the swinging engines on the car are covered in with steel plate. All gearing is covered by a protecting plate over the teeth which keeps flying rocks from blasting from getting into them, and is also a protection for the operator.

These novelties give the shovel a somewhat odd appearance to those accustomed to the usual housed-in shovel, but it is believed that in all vital and essential parts nothing is lacking to make a perfect machine and one which is on a distinctly higher plane as regards engineering design and quality of workmanship than any other.

Further particulars regarding this steam shovel will be gladly furnished by the Atlantic Equipment Co., of 25 Broad St., New York.

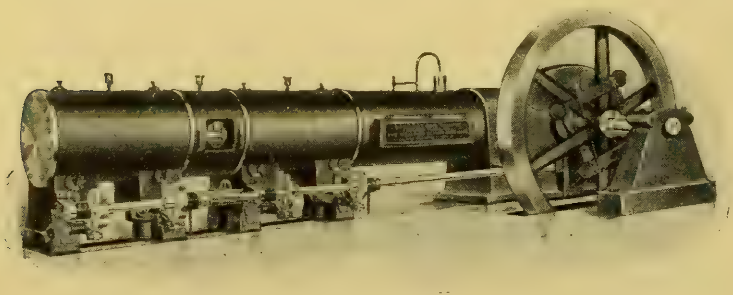


ATLANTIC STEAM SHOVEL.

The Sargent Complete Expansion Gas Engine.

THE Sargent engine was not only the first successful double-acting tandem gas engine, but the first and only one to expand the burning charge to practically atmospheric pressure, to vary the point of cut-off of the admission inlet with the load, and to advance the time of ignition as the admixture gets weaker and the inflammation slower. The advantages thus secured over the ordinary gas engine are: increased efficiency, increased regularity in speed, and smooth running under early cut-offs.

The general design, as shown in the illustration, is not only symmetrical and pleasing to the eye, but is such that all the strains come in a straight line, while the free expansion of the cylinders and rods is provided for. The sub-base, the top of which comes flush with the floor line, extends from end to end of the engine, thereby giving a flat planed surface upon which the engine is easily erected and aligned. The sub-base and main frame are bolted to the foundation, and the cross-head guide, cylinders and distance head, which fasten to the main frame, can come and go as the temperature varies, sliding on the hollow supports rising from the sub-base, which not only maintain the cylinders in line, but convey the gas and air from the hollow divided sub-base to the explosion chambers, thus doing away with the pipes, ordinarily so unsightly and in the way.



SARGENT COMPLETE EXPANSION GAS ENGINE.

A side shaft driven by the crank shaft and governor through a pair of worm gears, running in oil, carrying two cams for each explosion chamber, one for the igniter and one to operate the valve, comprises all the moving mechanism except the valves and lever, as shown, the other side of the engine being perfectly plain.

In the ordinary gas engine, the piston at full load draws in a cylinder full of combustible mixture, which, after compression and ignition, is expanded to the original volume and released at a pressure of 40 to 50 pounds absolute, and a temperature of from 1500° to 1800° F. In the Sargent gas engine the admission of gas and air at full load is cut off from five-eighths to three-quarters of the admission stroke, depending on the fuel used, which, after compression and ignition, is expanded to the cylinder volume and is released a little above atmospheric pressure with a corresponding temperature of about 400° F.

While the governor controls the speed through all ranges of load, the gas engine, like the steam engine, is not economical with very light loads. Where a variation in the turning moment is not objectionable, one or more of the explosion chambers may be cut out at will by the engineer, by simply raising to horizontal position a controlling lever, which holds the exhaust open and the gas and air closed. This is very desirable in blowing engines as they can be designed so that two explosion chambers will furnish air at 15 pounds and the four chambers at 30 pounds pressure.

Two electric igniters are placed in each explosion chamber in such a position that they are surrounded with a pure mixture at the time of ignition. Either will fire the charge, and should either become short-circuited, the engineer is immediately advised.

The engine is started by compressed air. The pressure of the air when turned on at one cylinder puts the starting mechanism into operation and at the same time puts the cylinder out of service as a gas engine. When the engine is up to speed, turning off the air puts the gas engine into commission without changing a valve, cam, or lever.

Every valve, lever, timing screw and part requiring adjustment, is readily accessible. All mechanism is above the floor line yet below the center line of engine. Every explosion chamber is accessible by simply removing the cylinder head, which can be done without further dismantling the engine. The time of ignition and the ratio of the gas and air may be changed while the engine is in operation.

The Wellman-Seaver-Morgan Company, of Cleveland, Ohio, have secured the exclusive right to manufacture and sell the Sargent Complete Expansion gas engine. They are prepared to furnish these engines in units of from 100 horse power up, in single-cylinder tandem and twin tandem styles, and for all purposes, and will gladly furnish further details on application.

Bickford Semi-Radial Drill.

THE greatly increased demands upon high-grade machine tools make it necessary for the manufacturers of such machinery to be continually on the alert to introduce improvements and to keep their products up to the very exacting modern requirements.

One of the latest forms of a typical up-to-date tool is shown in the accompanying illustration of a Bickford semi-radial drill.

The chief characteristics of this machine are rigidity, simplicity and durability which, combined with a high ratio of transmission gears, make it an admirable tool for many classes of work.

The head, on which all bearings are of uncommon length, consists of a single casting and is adjustable on the arm by means of a spiral gear which gives it an easy quick motion.

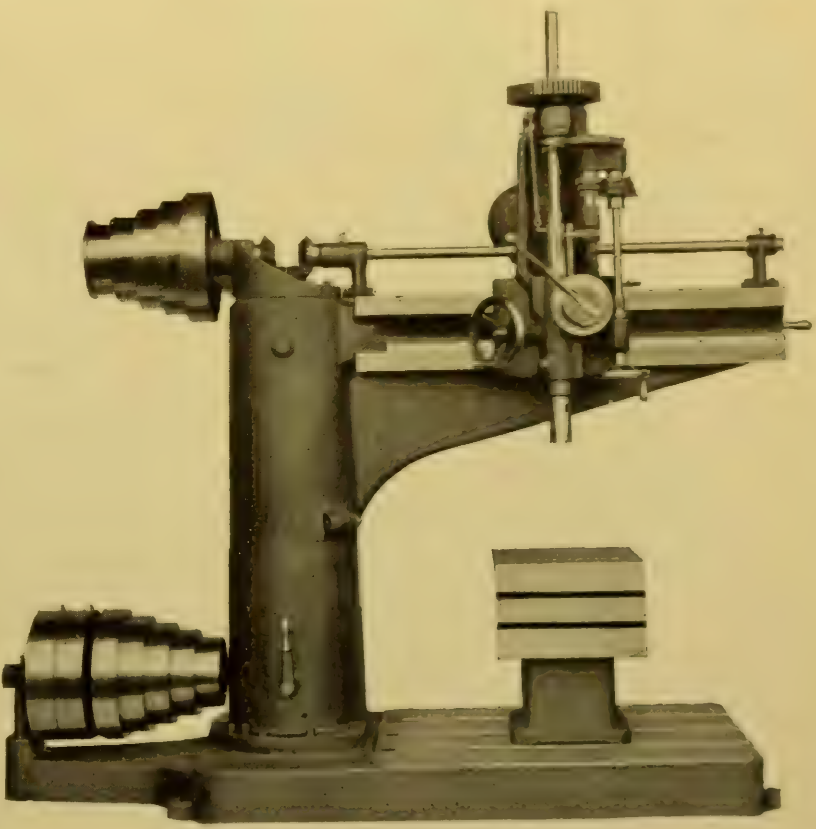
The spindle, which is made of hammered steel and has an unusually great vertical adjustment for a machine of its size, is provided with both hand and power feed and quick advance and return.

The feeding mechanism furnishes three rates of feed, advancing by even increments from .008 inch to .016 inch per revolution of the spindle, each of which is instantly available by means of our standard dive key.

The driving mechanism contains but seven gears, the pitch and periphery speed of which are conducive to long life. The speeds are five in number and advance in geometrical progression from 50 to 170 revolutions per minute.

The frame may be said to consist of but five parts, the base, column, cap, arm, and arm shaft, each of which are commensurate with the continuous severe work expected of a machine of this character.

The floor space required for this machine is 9 feet, 3 inches by 11 feet, 9 inches, and its net weight is 6,500 pounds. Further particulars will be gladly given by the manufacturers, The Bickford Drill and Tool Co., of Cincinnati.



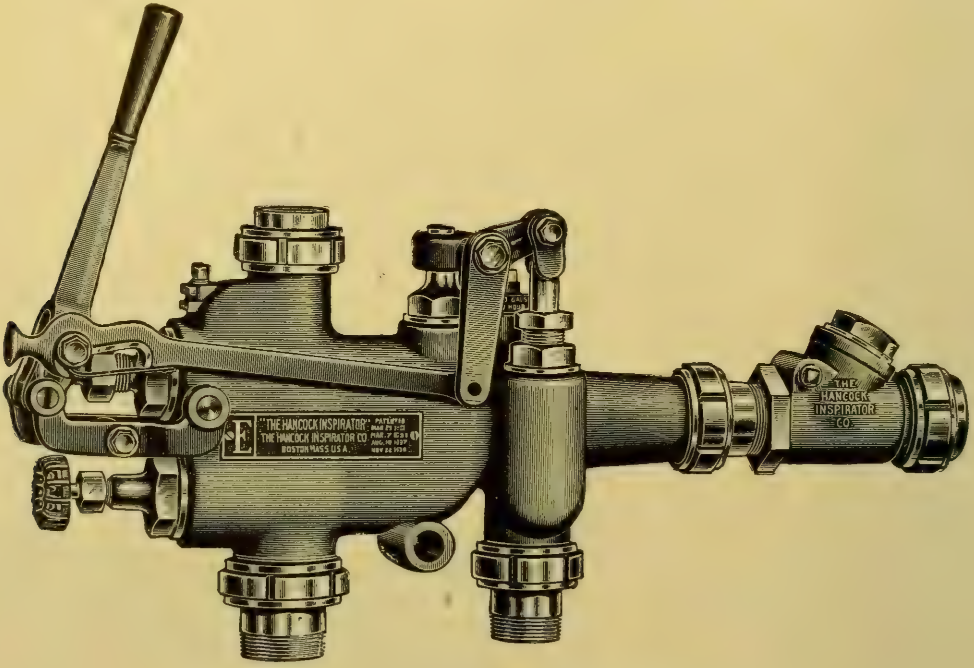
BICKFORD SEMI-RADIAL DRILL.

Hancock Locomotive Inspirator.

THE Hancock locomotive inspirator, Type E, is the latest production of the Hancock Inspirator Co., and has been designed to meet the present demand of railroads in standardizing their equipment. This apparatus is a lifting inspirator and is so made that by changing the nozzles and tubes only, it will be capable of delivering maximum capacities of 2,500 gallons, 3,000 gallons, 3,500 gallons, 4,000 gallons, 4,500 gallons, or 5,000 gallons per hour at a steam pressure of 200 pounds per square inch, lifting water 4 feet vertically with the feed water at 75 degrees Fahrenheit. By its use railroads are able to have one standard size inspirator for all sizes of locomotives, it being only necessary to insert in the inspirator the nozzles and tubes for the proper capacity to supply the locomotive. Thus only one size of spare inspirator and but one size of repair parts are required.

This inspirator is an ideal one for railroads desiring to standardize their equipment and reduce their supplies for maintenance to a minimum. In principle Type E is the same as the other types of well known Hancock inspirators, of which over 290,000 have been sold and are in use. It consists of a lifting apparatus which lifts the water and delivers it to the forcing apparatus, which in turn forces it into the boiler, the lifting apparatus acting as a governor, delivering the proper amount of water to the forcing apparatus for the proper condensation of the steam.

The great range of this inspirator demands more than ordinary attention. It is capable of feeding the boiler at any steam pressure between 35 and 350 pounds per square inch, without any adjustment of either the steam or water supply, and when the inspirator is in full working position at any of the above pressures, it cannot discharge the water except through the delivery pipe leading into the boiler. This inspirator will handle hot or cold water, and the capacity of each set of nozzles and tubes can be regulated for light or heavy service of the locomotive, so that the inspirator meets every requirement of a railroad having various types and sizes of locomotives.



HANCOCK LOCOMOTIVE INSPIRATOR.

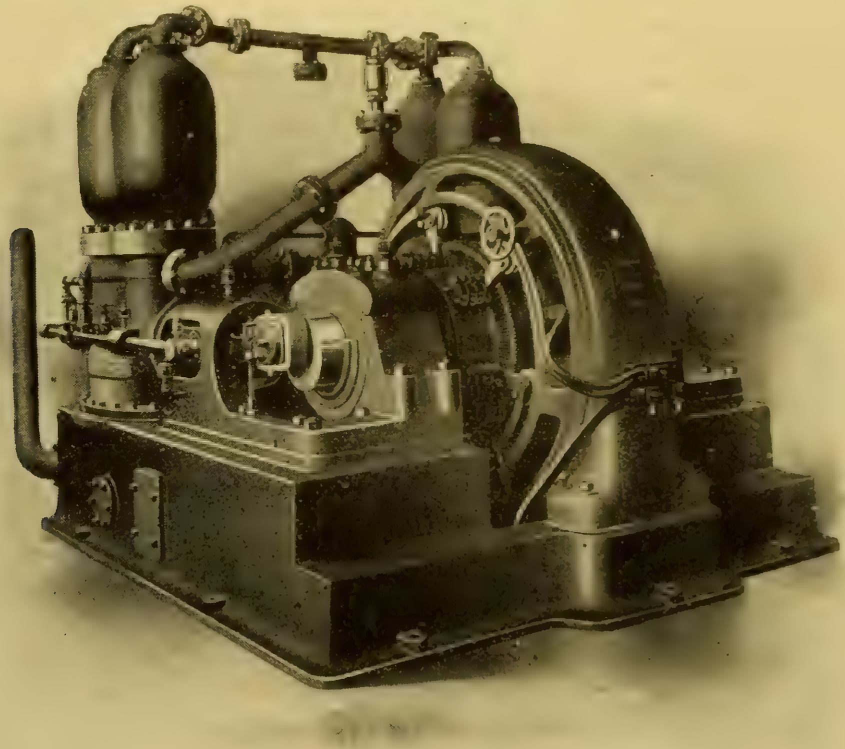
The Type E inspirator is fitted with an extra heavy Hancock swing check valve, which has been found so efficient and reliable with the higher steam pressures carried on the modern locomotive and with bad feed water. The capacity is regulated by the regulating valve, which increases or decreases the steam to the lifting apparatus. It has been found that this method of regulation, which has been used with all Hancock locomotive inspirators for the past twelve years, has been a most efficient one. The valve seats are all independent of the body casting and can easily be removed for renewal or regrinding.

Great care is taken in the material used. Each part is made of a special mixture of metal to best resist the wear. The stems are made of Tobin bronze, and all the nozzles, tubes, valves and valve seats are of a composition which does not contain any zinc. A capacity plate, showing the maximum gallons per hour delivered by the nozzles and tubes inserted, is fitted to the inspirator and clamped by means of a bolt, so that the engineer by glancing at it can tell at once the capacity of the tubes in the inspirator.

Any further information desired may be obtained from the Hancock Inspirator Co., 85, 87 and 89 Liberty St., New York.

A High-Speed Motor-Driven Pump.

THE operation of pumping machinery by electric motors offers, especially in mines, many obvious advantages, such as the centralization of the power plant, elasticity of extension of the system, high efficiency and small first cost and small expense for attendance. Compressed air may be used for the distribution of power to pumps, but it is not usually recommended on account of the low efficiency of the plant as a whole. Small leaks, if many, become serious, and the long line of piping with numerous joints causes frequent delay, trouble and expense. The use of steam for driving pumps at a distance and especially in mining operations, is decidedly objectionable on account of the loss by condensation, the heat from the engines and pipes, the expensive piping, the numerous joints liable to leak, and the possibility of danger from bursting pipes.



BLAKE-KNOWLES HIGH-SPEED ELECTRIC PUMP.

The electric-driven pumps, however, have had one drawback, which, while not serious, had nevertheless to be taken into account. This was the necessity of toothed gearing, belts or other devices to transfer the power from the rapidly revolving motor shaft to the slowly moving crank shaft of the pump. Such devices added to the weight and size of the pumping unit and required either careful attention or frequent repairs. The use of toothed gearing on pumps in buildings is objectionable, too, on account of noise.

In the pump which is illustrated herewith, these objectionable features have been eliminated by the simple expedient of connecting the pump plungers to cranks mounted directly upon the shaft of the motor. This pump has a capacity of about 250-gallons per minute against a 1,000-foot head when running at a speed of about 300 revolutions. So carefully have the internal parts of the pump been designed, however, that its mechanical efficiency is over 93 per cent., approximating closely to that of the highest types of large steam pumping engines. The pump is of the duplex type; the cranks at the opposite ends of the motor shaft being set at right angles to each other. The plungers are of the outside-packed pattern, and the two plungers of each pump are connected by side rods. The plungers are 3½ inches in diameter and have a stroke of 5½ inches. In a very carefully conducted test, the pump proved a success in every way, surpassing the expectations of the purchasers and even of the builders. The volume of water pumped was measured by means of a carefully constructed and calibrated Freeman nozzle, and all gauges were tested before and after the test by means of a weight gauge tester. The pressure at the nozzle was measured by a mercury column connected to a piezometer chamber. Under the greatest pressure the pump showed a remarkably high volumetric efficiency. The operation was practically noiseless under all conditions and was unaccompanied by the slightest shock or heating.

This type of pump, which has only lately been introduced, has salient advantages never before attained, including simplicity of construction, small space requirements, and cheapness of installation and attendance. The pumps are built by the Blake & Knowles Steam Pump Works, 114 Liberty St., New York City, in capacities of from 200 to 4,000 gallons per minute, and for heads varying from 100 to 2,000 feet, and further particulars may be obtained upon request.

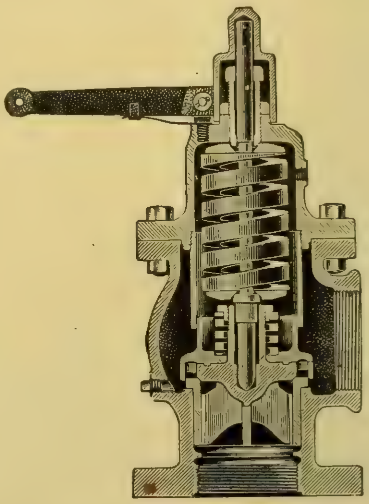
Crane Pop Safety Valves.

THE modern high pressures of steam and the all-round development of steam engineering make it necessary for the safety valve to keep pace with the general advance.

Realizing all this, the Crane Co., who have had a wide experience in the manufacture of valves, have brought out a number of improved forms of pop valves for stationary, marine, locomotive and portable boilers.

The construction of these valves embodies a self-adjusting feature which automatically regulates the "pop" of valve, or in other words, maintains the least waste of steam between the opening and closing points, an improvement which will be readily appreciated, as there is no necessity for re-adjusting to regulate the pop on changes in the set pressure.

This is more clearly explained as follows: In all pop safety valves it is necessary to have a pop or huddling chamber into which the steam expands when the main valve opens, thereby creating an additional lifting force proportionate to this increased area and greater than the force of the spring, thus holding the valve open until the pressure is relieved. Means must also be provided to relieve this pop chamber of pressure, in order to allow the valve to close promptly and easily. This is accomplished in the present valve by the self-adjusting auxiliary valve and spring, which are entirely independent of the main valve and spring. The steam in the pop chamber finds a passage through holes or ports into an annular space provided in the auxiliary valve or disc, and by reason of the light auxiliary spring, this pressure lifts the auxiliary valve and allows the steam in the pop chamber to gradually escape, thus permitting a greater range in setting pressures with the least waste of steam, and at the same time supplying a cushion or balancing medium, which prevents any chattering or hammering and affords the easiest possible action in closing.

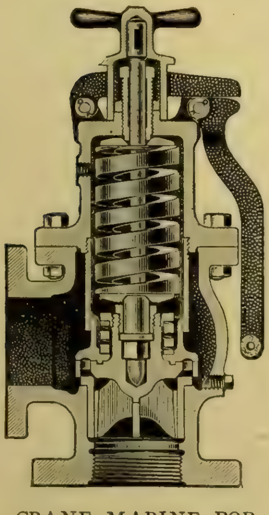


CRANE ENCASED SPRING POP SAFETY VALVE.

This feature is embodied in no other make of valve, and unlike other pop valves, in changing set pressures within reasonable limits of the spring capacity, nothing further is to be done but to simply turn down or out (for a higher or lower pressure) on the screw pressure plug at the top of the valve.

The encased spring valves are constructed with a casing or chamber enclosing both springs, so protecting them against the action of the steam, particularly high-pressure steam, which, blowing with great force and velocity throughout all parts of valve before reaching the atmosphere, would otherwise have a tendency to disarrange the springs and other parts operating in connection therewith.

This form of valve is also especially useful, in fact, necessary, where a number of valves may be connected to one main exhaust or discharge pipe. The encased spring chamber, extending over a greater portion of the top surface of the main valve, prevents any retarding action of the steam due to back pressure, which might be caused by one or more valves opening slightly in advance of others, from having any material effect on the free opening of the other valves.


CRANE MARINE POP SAFETY VALVE.

The composite marine pop valves made by the Crane Co. have been approved by the United States Board of Supervising Inspectors of Steam Vessels and comply fully with all the rules and regulations governing the United States Steamboat Inspection Service.

They have bevel seats at an angle of 45 degrees from the center line of their axis. The seats are made of composition or with solid nickel bushing, as may be required. The cam lever is capable of lifting the valve off its seat one-eighth the diameter of valve opening, whether or not there is pressure on the boiler. The cam lever may also be thrown over far enough to lock the valve open should occasion require or if it is desired to blow off all or a portion of the steam from the boiler through the safety valve.

The cap is made with handles or cross bars and fastened to the stem by a key pin. The stem in turn is securely attached to the main or wing valve, and, having a square section operating in a square socket or recess in the main valve, affords means of turning the valve on its seat, thereby removing any incrustation or saline matter that may accumulate.

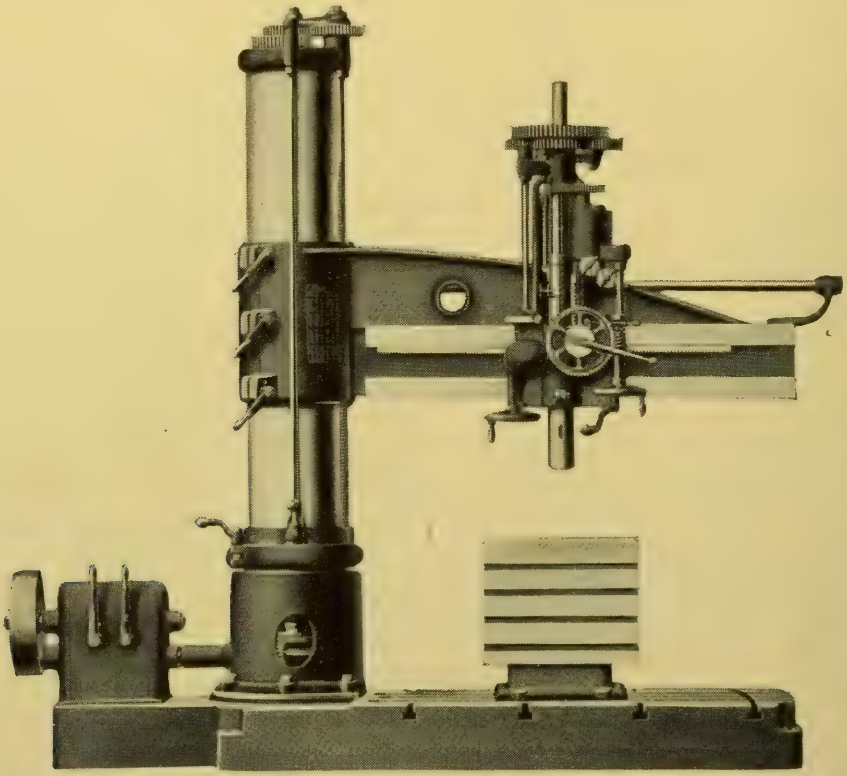
There is a self-adjusting pop regulator which automatically controls and maintains a minimum waste of steam between the opening and closing points, and there are encased springs, made of the best steel and with self-adjusting spring discs.

The valves can be taken apart without removal from the boiler and without disturbing the outlet pipe. All parts have been carefully designed and strongly proportioned, and when fitted and adjusted with correspondingly strong springs, these valves are suitable for pressures up to 250 pounds. Special valves for higher pressures are made to order.

The valves are furnished locked-up to prevent tampering, and further information concerning them may be obtained from the manufacturers, the Crane Co., of Chicago.

American Plain Radial Drill.

RADICAL changes have taken place, in the past few years, in the construction of radial drills. In order to keep fully abreast of the altered conditions and greatly increased duties now confronting the radial drill, the American Tool Works Co. have just redesigned their line of radial drills throughout, taking into account every condition influencing modern radial drill work, and every point which would tend to increase the efficiency of these tools. In the accompanying illustration is shown their new improved plain radial drill, which can be furnished with 4-foot, 5-foot, 6-foot or 7-foot arms. A feature of unusual excellence in this new drill is the feeding mechanism in the head, an entirely new and original construction. It provides eight distinct rates of feed to the spindle. These feeds are all obtained by the simple turning of a dial shown on the feed box, until the desired feed, indexed thereon, comes opposite a fixed pointer. This method is an extremely simple one, as it requires no reference to index plates and subsequent handling of levers. The feeds operate through a friction, which permits a drill being crowded to its limit without strain to the feed works. A plate is provided, indicating twist drill sizes, from ½ inch to 3½ inches, inclusive, and their respective feeds, and this, in connection with the dial index enables the operator to immediately secure the proper feed for the twist drill he is using. This involves no guesswork, saves a great deal of time, and insures the drill being used to its full capacity. Feeds can be automatically tripped at any position of the spindle by adjustable trip dog and pointer, acting on the worm clutch. Depth graduations are on the spindle, and all depths can be read from zero. Two or more dogs can be supplied, making it possible to counterbore any number of holes without resetting. The trip acts automatically at the full depth of spindle, so preventing breakage of feed mechanism.



AMERICAN PLAIN RADIAL DRILL.

The speed box is of the geared friction type, four changes of speed being instantly available by use of the two levers shown. The frictions are of the patent double-band type, employing very few parts in their construction, and they can thus be made of such large proportions as to be free from slippage under the severest cuts, so obviating the use of loose delicate parts. A motor of any type may be readily attached at any time, connection being made through chain, gear or belt. The speed box can be easily interchanged with a cone by simply breaking a coupling connection on the lower driving shaft of the machine.

The spindle has sixteen changes of speed, all instantly available without stopping the machine. This wide range of spindle speeds, combined with the exceptional driving power of the machine, renders the drill equally efficient with either ordinary or high-speed twist drills.

The column is of the double tubular type. The outer column is practically integral with the inner column, which extends the entire height and has full bearing for the outer column at both top and bottom.

The arm is of parabolic beam and tube section, giving the greatest resistance to bending and torsional strain. Its design leaves the lower line parallel with the base, and thus permits work being operated upon in close proximity to the column without the necessity of an extreme reach of spindle. The arm is raised and lowered rapidly by a double-thread, coarse-pitch screw hung on ball bearings, and controlled instantly by a convenient lever.

Further particulars will be cheerfully furnished by the makers, the American Tool Works Co., of Cincinnati.

The Bitulithic Pavement.

FOUR years ago there was introduced to the engineering world a new style of street paving which was laid in Pawtucket, R. I., and it at once enlisted earnest attention, as it was a radical departure from all accepted forms of roadway. A few thousand yards of this paving, which is now universally known as the Bitulithic pavement, were designedly laid in locations which would develop any weaknesses the pavement might possess. One section was constructed in Harvey Street, a much traveled way having a 12 per cent. grade, and another in Park Place near the entrance to the principal fire engine station in the city.

The pavement was watched with the greatest care in order to discover any weaknesses, and tours of inspection were made to Pawtucket by hundreds of engineers, city officials and practical road builders for the express purpose of investigating the Bitulithic. The patentees of the Bitulithic pavement, the Warren Brothers Company, the members of which firm had beeen identified with the asphalt industry from its inception in the United States to the introduction of the Bitulithic pavement, offered every facility for investigation by throwing open to the public their laboratories, being as anxious to discover any minor defects as any one in order that they might be remedied, their faith in the inherent qualities of their invention being unassailable. From the small beginning in Pawtucket of 2,100 square yards, which in four years has not cost a penny for repairs and is as good today as when originally laid, the business of the company grew in the first year to 16,400 square yards, laid principally in experimental stretches in sections most likely to disclose any weaknesses it might possess; but none were found, and practical tests under traffic showed that it bore out in every particular the claims of the patentees, which are, that the stone of which it is composed takes the wear of traffic; it is less noisy than any other pavement; it will not rot and disintegrate; horses will not slip on it in any weather; it is free from dust and mud; and it may be successfully laid on top of old stone blocks, bricks, macadam or asphalt, if they have not rotted.

The investigations of the Bitulithic pavement in its early life bore abundant and early fruit, as in 1902 it was adopted in 32 cities to the extent of 365,932 square yards; in 1903 in 40 cities to the extent of 800,071 square yards; and up to August 1 of the present year contracts have been awarded in 42 cities for over one million square yards.

Nine miles of the Bitulithic pavement have been laid in St. Louis, Mo., Lindell Boulevard, the principal thoroughfare leading to the main entrance of the Louisiana Exposition being among the streets so paved.

The beginning of the Warren Brothers Company was a modest one, a single small office in Boston being deemed sufficient for immediate needs, but the business soon outgrew these cramped quarters and development since has been so great as to compel two removals, until at the present time an entire floor in one of the largest office buildings in Boston and fifteen branches in the principal cities of the United States are required to attend to the rapidly increasing demand for the Bitulithic pavement.

Boring and Turning Mill with Turret Head.

A THIRTY-INCH boring and turning mill with turret head, equipped with a full set of adjustable tools for finishing gear blanks ranging in size from 4 inches to 24 inches in diameter with but two settings, is shown in the accompanying illustration.

The blank is secured by finger jaws gripping the inside of the rim. It is readily brought to true by the combination chuck in the table, and is brought level with the table by the parallel blocks on which it rests.

The upper tool holder, carrying a four-lip core drill, an outside turning tool and two facing tools for the rim and the hub, respectively, completely roughs one side of the blank while the hole is being rough bored.

A single point boring tool is next run through the bore at a racing cut to insure concentricity, leaving just enough metal to be cleaned up by a special universal joint reamer to finish the bore absolutely true and to size.

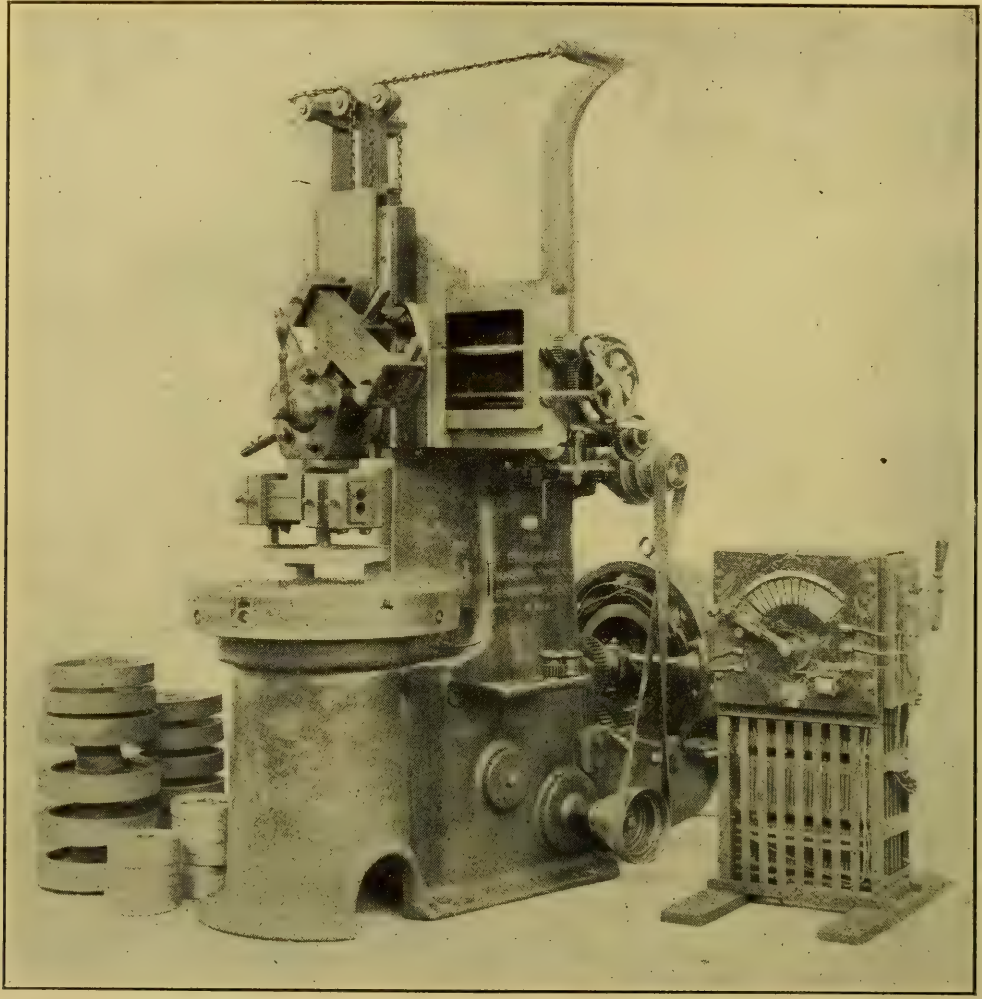
The lower tool holder is of the same design as the upper one, but carries a standard sized guide plug which, in entering the bore, insures concentricity of diameters and also adds to the stability of the tool. A second tool finish-turns the outside diameter of the blank to size, and has completed its operation before the finish-facing tools are brought into action on the rim and the hub. The corners of the rim and hub are rounded off by two other tools.

In the second setting a stud (the diameter of the bore of blank) is fitted into the center of the hole in the table and a driving stud set in the T slot of the chuck jaw. A blank is then dropped over it, and the upper tool holder, minus the four-lip core drill and the outside turning tool, roughs the faces of the rim and the hub, which are finished by the corresponding tools in the lower tool holder, the rounds being formed as before by the appropriate tools.

The method of holding the blank from the inner surface of the rim insures uniform thickness of the rim when finished, and, by the use of the guide plug in the finishing tool, the outside diameter is not only turned absolutely true to size but runs on centers within .0005 of an inch.

The tools used in the holders number twelve, and all operations are completed without moving the turret slide from its central position on the rail, thereby saving all the time usually required to set tools and caliper for diameters.

All gears of the above sizes are finished in this way at the shops of The Bullard Machine Tool Co., Bridgeport, Conn., and a saving of from 50 to 75 per cent. is made over the more common method of separate chucking and turning on arbors. Furtner information concerning these tools and operations will be gladly furnished by the above-named company.



BULLARD TURNING AND BORING MILL WITH TURRET HEAD.

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